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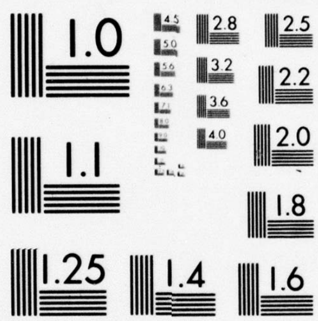

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COLLECTION OF ARTICLES ON WASTEWATER AND ITS USES FOR IRRIGATION IN THE SOVIET UNION.

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As a result of the high concentration of cattle in livestock farms, the elimination of cattle bedding, and the total mechanization of the removal of the manure from the premises a new type of waste water has developed -- the outflow of animal husbandry complexes consisting of a mixture of droppings, and feed and water waste, used for industrial feeds. In connection with the reconstruction and building of new specialized animal raising complexes by 1980 the volume of animal husbandry outflow will more than double. This

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report discusses animal wastewater uses in irrigation.

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SOIL PURIFICATION OF WASTE WATER ON IRRIGATION FIELDS

POCHVENNAYA OCHISTKA STOCHNYKH VOD NA POLYAKH OROSHENIYA in Russian pp 31-35

[Article by Candidate of Agricultural Sciences V. T. Dodolina (VNIISSV)]

In recent years VNIISSV has conducted studies of the purification of waste water on irrigation fields. Used for the irrigation of farm crops, the waste water is filtered and purified as a result of the specific characteristics and properties of the soil. The soil is a dispersion biogenic body. The degree of dispersion depends on mechanical composition of the soil. The greater the dispersion of the soil and the more colloids it contains, the greater its absorption capacity becomes. All suspended and coloring substances are retained by the soil. The dissolved mineral and organic substances absorbed by the soil turn into simple substances as a result of physical and chemical processes (carbon dioxide, water, bicarbonates, nitrates and others).

Waste water of different structure is used in irrigation, distinct in terms of color, odor, amount of suspended sediment, ammoniacal nitrogen content, and organic matter. Table 1 offers a short description of the physical and chemical characteristics of the basic types of waste water released by industrial enterprises.

Studies have shown that Chernozem, chestnut-colored, soddy-podzolic, and gray forest soils can properly purify a great variety of waste water. A lysimetric series of experiments was conducted on the purification of waste water by different soils. The lysimeters used were made of polyethylene pipes, 200 mm in diameter, 0.7 meters high, and of metal pipes, 1000 mm in diameter, 1 meter high. The soil put in the lysimeters was consistent with the genetic structure of the layers. Waste water was run through a 70-100 centimeter thick soil stratum. Its composition for all basic indicators characterizing purification was studied in advance (color, odor, pH, amount of suspended and dissolved matter, ammoniacal nitrogen content, bichromatic oxidization, and biochemical O_5 requirement). The thus obtained filter was studied for the same indicators. The amount of waste water poured in each lysimeter was sufficient for obtaining a filtrate.

Table 1

Physical and Chemical Properties of Waste Water Released by Industrial Enterprises

Таблица I

Физико-химические свойства сточных вод промышленных предприятий

№	Сточные воды	Цвет	Запах	Прозрачность, см	Взвешенный осадок, г/л	Концентрация растворенных веществ, г/л	Аммиачный азот, мг/л	Окисляемость, мг/л O_2 (12): перманганатная	бихроматная	$БПК_5$	Примечание
	1	2	3	4	5	6	7	8	9	10	11
(13)	Хозяйственно-бытовые городов и поселков	серый (14)	фекальный (15)	5-7	0,2-0,3	0,4-0,8	I8-35	70-II2	I70-250	I48-I67	
(16)	Текстильных предприятий тонкосуконного производства	серовато-фиолетовый (17)	специфический (18)	3-6	0,3-0,5	0,6-0,8	I5-29	I28-I4I	280-344	I85-256	
(19)	Текстильных предприятий коврового производства	бордово-синий (20)	то же (21)	4-7	0,3-0,5	0,8-I,I	I8-27	I52-I85	I68-325	I79-248	после механической очистки (22)
(23)	Текстильных предприятий хлопчато-бумажного производства	темно-сине-фиолетовый (24)	-"-	3-5	I,0-0,3	0,7-I,4	I4-25	I42-I88	2I5-3I2	I68-235	-"-
(25)	Химико-фармацевтических заводов	желто-бурый (26)	Аммиачно-фекальный (27)	5-9	0,2-0,5	2,5-5,3	98-I46	-	I288-2485	III2-I875	
(28)	Химических комбинатов (условно-чистые и общий сток)	серо-бурый (29)	Специфический (18)	6-8	0,I-0,7	I,5-5,0	25-I83	-	232-I546	225-I233	
(30)	Крахмальных заводов от производства картофельного крахмала	серо-белесый (31)	то же (21)	3-4	0,6-2,4	I,3-3,5	47-82	-	I900-2883	I648-2232	без очистки (32)
(33)	Крахмальных заводов от производства кукурузного крахмала	кремоватый (34)	-"-	2-5	0,5-2,7	I,2-2,4	37-65	-	I805-3I26	I7I2-2435	

Продолжение табл. I

№	I	2	3	4	5	6	7	8	9	I0	II
(35)	Сахарных заводов	серо-белесый (31)	специфический (18)	2-3	I,2-5,0	I,5-3,3	27-34	-	I500-I980	I202-I725	
(36)	Гидролизных заводов	зеленовато-бурый (37)	-"-	4-6	0,3-0,9	2,5-7,8	83-I35	-	I580-2450	-	
(38)	Мясокомбинатов	буро-красный (39)	-"-		0,7-0,9	I,4-3,5	56-87	-	I754-222I	-	

[Key on p 3]

[Key to Table 1]:

1. Waste water
2. Color
3. Odor
4. Clarity
5. Suspended sediment, grams per liter
6. Concentration of dissolved substances, grams per liter
7. Ammoniacal nitrogen, mg per liter
8. Permanganate
9. Biochromatic
10. Biological intake of O_5
11. Notes
12. Oxidability, mg per liter of O_2
13. Industrial-residential towns and settlements
14. Gray
15. Fecal
16. Textile enterprises, fine woolen fabric production
17. Grayish-violet
18. Specific
19. Rug making textile enterprises
20. Bordeau red-blue
21. Ibid
22. After mechanical purification
23. Cotton fabric textile enterprises
24. Dark blue-violet
25. Chemical-pharmaceutical plants
26. Yellow-brown
27. Ammonia-fecal
28. Chemical combines (conventional pure and general effluent)
29. Gray-brown
30. Potato starch manufacturing plants
31. Gray-whitish
32. Without purification
33. Corn starch manufacturing plants
34. Cream colored
35. Sugar refineries
36. Hydrolysis plants
37. Greenish-brown
38. Meat combines
39. Brown-red

Waste water with the following physical and chemical indicators was considered purified: the water must be transparent, have no odor or color; the pH must range from 6.0 to 8.2; ammoniacal nitrate must not exceed 3-5 mg per liter and permanganate oxidability should range between 12 and 15 mg per liter of O_2; the biochemical O_5 requirement should be between 2-5 mg per liter of O_2, and clarity should exceed 15 cm.

Table 2 shows the results of the studies.

At an irrigation norm of 700-1000 cubic meters per hectare the various types of waste water can be adequately purified by Chernozem, soddy-podzolic, and gray forest soil. Going through a 70-100 cm soil stratum the waste water becomes colorless and transparent, and has no odor, i.e., the soils absorb 100% of all suspended and coloring matter. This is confirmed by transparency data: from 3-5 cm transparency increased to 20-29 cm. The absence or slight content of ammoniacal nitrogen indicates the high level of purification (compared with the initial data the content was reduced by 98 to 100%). The same pattern was established for the dissolved organic matter absorbed by the soil 90 to 95%.

Consequently, waste water can be perfectly purified by the soil. Under industrial conditions such purification is achieved by the entire aerated stratum (to the groundwater level), whose thickness varies for most areas from 2.5 to 25 meters. In this case the groundwater receives entirely purified waste water.

The substances which have entered the soil are consumed by the plants and soil microorganisms or else break down into simple compounds under the influence of physical and chemical processes. The control of norms and irrigation periods enables us to achieve high results in the purification of waste water on irrigation fields.

Table 2

Composition of Waste Water After Purification Through Various Soils
(based on lysimetric experiment)

Сточные воды (1)	Тип почвы (2)	Норма полива, м³/га (3)	Глубина почвенного слоя, см (4)	Прозрачность, см (5)	Сухой остаток, мг/л (6)	pH	Азот аммиачный, мг/л (7)	Окисляемость бихроматная, мг/л O_2 (8)	БПК$_5$, O_2 (9)
Тонкосуконной фибрики (10)	дерново-подзолистая супесчаная (11)	I000	70	20	250–300	6,8	нет (22)	75–98	7–II
(12) Коврового комбината	То же (13)	I000	70	22	325–400	7,I	нет	87–I02	6–I2
(14) Крахмального завода от производства картофельного крахмала	серая лесная (15) суглинистая	700	70	25	580–700	7,0	нет	95–I28	24–56
(16) Сахарного завода	чернозем (17) суглинистый	700	70	24	425–650	7,4	нет	88–I35	I8–42
(18) Химико-фармацевтического завода	дерново- (11) подзолистая супесчаная	I000	I00	27	924–II23	6,3	3–I2	I22–I58	28–63
(19) Хозяйственно-бытовые	то же (13)	I000	70	29	289–376	7,0	нет	48–67	8–I8
Мясокомбината (20)	дерново- (21) подзолистая суглинистая	600	70	23	578–7I4	7,0	2–7	I02–I58	25–45

Key:

1. Waste water
2. Soil type
3. Irrigiation norm, m³ per hectare
4. Depth of soil stratum, cm
5. Transparency, cm
6. Dry residue, mg/liter
7. Ammoniacal nitrogen, mg/liter
8. Bichromatic oxidability
9. Biochemical O_5 requirement, O_2
10. Fine woolen cloth fatory
11. Soddy-podzolic sandy loam
12. Carpet making combine
13. The same
14. Potato starch manufacturing plant
15. Gray forest loamy
16. Sugar refinery
17. Loamy Chernozem
18. Chemical-pharmaceutical plant
19. Industrial-residential
20. Meat combine
21. Soddy-podzolic
22. None

Remark. The waste water used was odorless and contained no suspended matter.

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BIOLOGICAL OXIDATION OF WASTE WATER PRIOR TO ITS UTILIZATION IN AGRICULTURE

BIOLOGICHESKAYA OKSIDATSIYA STOCHNYKH VOD PERED ISPOL'ZOVANIYEM IKH V SEL'SKOM KHOZYAYSTVE in Russian pp 36-40

[Article by Candidate of Agricultural Sciences Ye. I. Zhirkov and Engineer A. N. Tereshina (VNIISSV)]

In addition to helminth eggs, residential waste water contains a great quantity of pathogenic microorganisms and viruses. Many agents of infectious diseases may live in polluted soil long periods of time. Thus, dysentery microbes can survive in the soil up to 45 days, while those of typhoid fever may survive up to 1 years; ascarides ova remain viable for over 7 to 8 years [1]. That is why waste water must be purified and decontaminated before irrigation. Their dehelminthizing and decontamination is accomplished most effectively in biological oxidation contact stabilization (BOCS) ponds developed by the VNIISSV [4]. The purified and decontaminated waste water is then directed to irrigated farm fields. The result is not only a certain income obtained through higher farm crop yields but also the fact that the waste water does not penetrate water basins and water flows. This method is being presently applied in the Tadzhik, Uzbek, and Turkmen SSR's, the RSFSR, and the Estonian, Lithuanian, and Latvian SSR's.

Waste water for the irrigation of perennial grasses is treated in the BOCS ponds of Talsy in the Latvian SSR. The waste water flows into the BOCS ponds after passing through a twin layer sedimentation tank mixed with rain precipitation water (on an average of 400 cubic meters per day). In the summertime the BOCS ponds are governed by a sliding filling schedule. In a 24-hour period a section is filled to a planned depth level (60 cm), after which water enters the next section. In July 1971 an algological set consisting of chlorophyceae, Cyanophyceae, and diatoms was added to experimental-industrial BOCS ponds. The self-purification process of waste water in such ponds was quite intensive. Toward the end of the first day the waste water became considerably more transparent compared with the new flow, the fecal odor disappeared, and, thanks to the intensive multiplication of microalgae, it acquired a greenish coloring. Research conducted between 1971 and 1973 showed that on the third day the concentration of Bacillus coli bacteria was reduced by 85%; 5-7 days after the introduction of the microalgae in the pond it declined by over 99% (Table 1).

Table 1

Decontamination of Waste Water in Talsy Bioponds

Observation time, days	Water temperature, °C	Overall No of metatrophic bacteria per mg	No of Bacillus coli bacteria per mm	Elimination %
0	15	36000	7200	-
1	18	17980	5020	30
3	17	9600	1050	86
7	18	2800	40	99.4
9	18	950	6	99.9

Depending on seasonal temperature fluctuations the indicators of the elimination of the Bacillus coli bacterial group were somewhat different from the table figures. The deviations, however, were insignificant.

Industrial-fecal waste water, purified in bioponds, are safe from the epidemiological viewpoint following the 99% destruction of the Bacillus coli bacterial group. This phenomenon is indicative of the reliable decontamination of the purified water from the agents of typhoid fever, paratyphoid A, paratyphoid B, and various types of dysentery [6]. Consequently, waste water purified in BOCS ponds is suitable for irrigation and safe from the medical-epidemiological viewpoints. The 3-year long experiment in the use of BOCS ponds in Talsy indicated that the decontaminated waste water corresponded to the beta-mesosaprobic zone of water flows and reservoirs in terms of organolepic, hydrochemical, physical-chemical, and microbiological indicators.

Additional control of the existence of individual or combined toxic ingredients in waste water is expedient (and, in a number of cases, necessary); we must also control the level of mineralization and cation composition of waste water; the content of nutritive elements in the waste water, needed by the plants, and changes in the content in the course of their treatment in BOCS ponds.

In terms of chemical composition (data of 16 June 1973) the Talsy waste water falls within the category of industrial-residential water (Table 2). Its qualitative and quantitative characteristic is quite homogeneous, for which reason the question of the toxicity of such water is eliminated. In terms of suitability for irrigation, the industrial-residential waste water could be used for soils of all types without dilution [3].

The waste water had an average content of 30-50 milligrams per liter nitrogen, 5-12 phosphorus, and 15-30 potassium. It had low mineralization and a favorable cation structure ratio. In the course of its treatment in BOCS ponds we noted an increase in general nitrogen which may be explained, apparently, by the capacity of microalgae for atmospheric nitrogen fixation. Under laboratory conditions, exposed to light, their fixation capacity

ranges from 20 to 50 mg of nitrogen per liter of medium [2]. Our observations indicated that the addition of general nitrogen in BOCS ponds did not usually exceed 10 mg per liter, averaging about 5% of the initial content. A case was noted in which the nitrogen content in waste water was increased by as much as 28%.

The fixation of atmospheric nitrogen by Cyanophyceae is a complex process determined by a number of conditions, many of which have remained so far unstudied. This particularly applies to BOCS ponds whose conditions are different from those of laboratory and industrial systems for mass algae growing.

In 1973 the nitrogen fixation by Cyanophyceae was studied in laboratory models of BOCS ponds. Two rigid containers (2 cubic meters each) were filled with industrial-fecal waste water from the Monino settlement, whose composition is similar to Talsy waste water. One of the containers was experimental and contained microalgae, while the other was used as control. Daily samples were taken to determine the general nitrogen content. The studies covered two cycles of BOCS pond use in the course of which the water was treated 7 days in the first and 10 in the second. In the first cycle the general nitrogen content in the experimental container rose from 38 to 45 mg per liter; in the second it rose from 50 to 52 mg per liter and was almost undistinguishable from the control samples. Despite the certain conventionality of laboratory studies, they confirm the possibility to enrich with nitrogen waste water subjected to biological decontamination in bioponds.

Taking into consideration the nitrogen fixation ability of Cyanophyceae, currently methods are being developed for their mass cultivation in industrial type facilities with a view to their future use as fertilizer on irrigated soil [5]. However, such systems have not as yet become widespread. Therefore, the growing of Cyanophyceae in BOCS ponds could be considered one of the possible means for their mass cultivation under natural conditions and for upgrading fertilizing value of waste water.

Therefore, after their decontamination in BOCS ponds industrial-fecal waste waters are safe from the hygienic and epidemiological viewpoints and could be used on irrigated farm land. The fertilizing properties of waste water do not worsen after treatment in BOCS ponds. Under certain conditions, thanks to the nitrogen fixating activities of the algologic complex applied in the ponds, they even improve.

Table 2

Chemical Composition of Talsy Waste Water in BOCS Ponds, mg/liter

№ пруда (1)	pH	Взвешен. осадок (2)	Остаток (3)		Cl'	SO_4	Ca''	Mg''	Na'	K'	Азот (6)		P_2O_5	Окисляемость (9)	
			сухой (4)	прокален. (5)							общий (7)	аммонийн. (8)		перманганатная (10)	бихроматная (11)
I	8,3	483	695	345	67	49	78	4I	78	24	45	38	5	74	352
2	8,3	380	675	330	57	47	64	50	85	22	53	25	6	80	384
3	8,I	282	620	356	55	6I	76	5I	72	2I	50	28	5	58	352
4	8,4	297	635	460	76	57	66	49	78	26	39	22	6	66	320
5	7,9	293	630	345	59	66	66	5I	72	20	45	27	5	53	286
6	7,6	26I	5I0	390	53	74	64	23	52	I6	55	24	6	58	256
7	8,2	269	620	440	76	78	64	22	90	24	44	39	I2	46	244
8	8,2	236	565	350	67	86	72	23	72	20	33	23	8	32	I60
9	8,0	253	575	420	57	56	60	23	60	28	60	27	7	46	256

Key:

1. Pond No
2. Suspended sediment
3. Residue
4. Dry
5. Hardened
6. Nitrogen
7. General
8. Ammoniacal
9. Oxidability
10. Permanganate
11. Bichromatic

BIBLIOGRAPHY

1. Горбов В.А. Санитарная охрана почвы. М., "Медицина", 1971.
2. Горюнова С.В., Ржанова Г.Н., Орлеанский В.К. Сине-зеленые водоросли. М., "Наука", 1969.
3. Додолина В.Т. Классификация сточных вод по пригодности их для орошения. - В кн.: Сельскохозяйственное использование сточных вод. М., 1972.
4. Доливо-Добровольский Л.Б. Подготовка сточных вод, направляемых на орошение. - В кн.: Сельскохозяйственное использование сточных вод, М., 1972.
5. Музафоров А.М., Кучкарева М.А., Воронова О.Г., Тохре П.М. Массовое культивирование азотфиксирующих сине-зеленых водорослей в условиях Узбекистана. - В кн.: Новое в изучении биологической фиксации азота. М., "Наука", 1971.
6. Gloyna E. Waste stabilization Pond Concepts and Experiments World Helth Organization, 1965.

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ON A METHOD FOR DETERMINING THE USEFULNESS OF WASTE WATER IRRIGATION

ISPOL'ZOVANIYE BYTOVYKH I PROM'SHLENNYKH STOCHNYKH VOD V SEL'SKOM KHOZYAYSTVE in Russian pp 42-47

[Article by Candidate of Agricultural Sciences L. Ye. Kutepov, VNIISSV]

Study of the Chemical Composition of Waste Water

The utilization of waste water in irrigated fields requires a knowledge of their chemical composition. Its study requires the separate consideration of its mineral structure and pollution with organic matter.

In most types of waste water the basic mineral salts include sulfates, chlorides, and the bicarbonates of sodium, potassium, calcium, and magnesium. These salts are basic in soils and in natural waters. Data are available on soil-hydrogeological conditions and the irrigation system, and the admissibility of the concentration of such salts in irrigation waters.

Irrigation water must have a reaction with the environment close to neutral (pH 6-8). In the irrigation of acid soils it would be desirable to change the pH value toward the alkaline side (pH 7-9); in the case of alkaline soils the acidity should be higher (pH 5-7). Obtaining the necessary pH value for waste water prior to its utilization for irrigation presents no technical difficulties. The quantity of nutritive elements needed by the crops, applied with the irrigated water, should not substantially exceed specific plant requirements.

A number of elements (heavy metal, arsenic, selenium) may have a toxic effect on the soil microflora or the plants, or accumulate in the plants and, in turn, thus adversely affect animals and humans. Such waters are either unsuitable for irrigation or could be used after preliminary treatment.

Usually, the salt structure of industrial waters is limited to sulfates, chlorides, and bicarbonates of calcium, magnesium, sodium and potassium. The existence of bicarbonates and carbonates should be determined only in the case of alkaline waters. Thus, irrigation water should have a pH value close to neutral and carbonates and bicarbonates should be almost nonexistent.

The simplest testing system which would meet the reclamation requirements would be to determine the overall mineralization and cation structure in the water samples (sodium, potassium, calcium, magnesium). General mineralization must equate the sum total of equivalent concentration of cations and could be determined through conductimetry.

The presence of organic matter in water samples is determined, above all, on the basis of overall bichromatic oxidability. Should bichromatic oxidability exceed 200 mg per liter of O_2 we must determine the organic substances which pollute the waste water. According to the type of production technology the basic organic pollutants are identified and the substances whose concentration, based on production technology, could exceed average daily samples by 20-30 milligrams per liter must be analytically identified.

A considerable biological mass of microorganisms is found in the effluent following biological treatment and, in summer, in storage ponds. Such microorganisms are oxidized bichromatically and substantially exceed the determined quantity of organic pollutants. The biomasses in the water could be considered only as fertilizers. Therefore, prior to the analysis of such water samples, the biomass must be separated through centrifugal separation, or filtration using a membrane or Selzer filter.

Irrigation Requirements Concerning the Mineral Composition of the Water

The optimal concentration of salts in soil solutions is within the range of 45 to 75 milligrams-equivalent/liters (3-5 grams per liter). With this concentration the amount of salts released with the crop is considerably lower than the gross salt content in the soil water used for transpiration. Therefore, in irrigation practice water containing no more than 15 mg-equivalent per liter salts is considered suitable while water containing salts in excess of 45-105 mg-equivalent per liter could be used only on an exceptional basis in the presence of an ideal draining system and with irrigation flushing.

In his report presented at the UNESCO symposium on the salinization of soils and water sources, V. A. Kovda drew the attention to the fact that irrigation with mineralized waters is possible through flushing, i.e., by maintaining the outflow of water and the elimination of accumulating salts from the root stratum and only with intensively operating draining systems.

The report stated the following:

An annual extra-vegetational flushing is required in the case of a 2-3 grams per liter mineralization of irrigation waters;

One flushing irrigation after 4-5 conventional waterings is required with a 4-5 grams per liter mineralization of irrigation water;

Each second or third watering should be a flushing in the case of 7-8 grams per liter mineralization of irrigation waters;

Frequent high volume watering should be applied, exceeding the water retaining capacity of the soil, with an intensively operating draining system, are necessary with a 10-12 grams per liter mineralization of irrigation waters.

However, even the good draining of soils irrigated with water containing essentially sodium salts could solonetzize and become impermeable to water. Circular No 969 of the U.S. Department of Agriculture states that water in which

$$\frac{Na}{\sqrt{\frac{Ca+ug}{2}}} < 8. \qquad (1)$$

presents no soil solonetzization thereat.

The cation content in formula (1) is in milligram-equivalents per liter.

O. Izrael'sen suggests the following classification of irrigation waters based on the percentage of sodium content in the sum total of cations (in milligram-equivalents per liter): good, less than 65%; satisfactory, 66-75%; poor, over 75%. Using the same principle A. M. Mozheyko and T. K. Vorotnik suggest a similar classification of irrigation waters: good, under 65%; satisfactory, 66-75%; poor, over 75%.

M. F. Budanov recommends for irrigating the territory of the southern part of the Ukrainian SSR the use of waters with a mineralization not exceeding 3 grams per liter providing that the overall mineralization (in milligram-equivalents per liter), divided by the value of the hardness should not exceed 2 for medium and heavy loamy soils, 2.5 for light loamy soils, and 3 for sandy loam and sandy soils.

I. N. Antipov-Karatayev and G. M. Kader believe that the strictest possible determination of constants of adsorption exchange between the soil absorbing complex and soil solution should be computed on the basis of the following equation:

$$\frac{\sqrt{x(Ca+ug)}}{X_{Na}} = \frac{K\sqrt{C(Ca+ug)}}{C_{Na}}, \qquad (2)$$

in which X is the content of absorbed cations, and C is the content of cations in irrigation water. This equation is the basis for formula (1) for the irrigation rating of the water. Should the water contain a substantial amount of potassium salts it is added to the sodium content in determining the quality of the irrigation water.

Experience in irrigating with waste water with a mineralization of up to 3 grams per liter in different soil and climatic zones in the USSR has shown that all the above-enumerated methods could be used in assessing the quality of irrigation water.

Possibility for the Decontamination of Waste Water Polluted with Organic Matter on Irrigated Fields

The decontamination of waste water on irrigated fields and at artificial biological treatment systems consists of developing living organisms of organic matter as a source of carbon nutrition. This offers a number of advantages compared with artificial treatment systems, based on the following principal conditions of irrigated fields:

a) Organically polluted waste water goes through 2-3 biological barriers (soil microorganism, plants, domestic animals);

b) With its tremendous surface of soil particles, colloidal in particular, the soil has great absorbing capacity as a result of which standard irrigation and sprinkling norms exclude the pollution of ground waters and lower the concentration of organic matter in the soil solution. This considerably facilitates the development of biochemical processes;

c) The existence in the soil of the tremendous quantity of a great variety of microorganisms under normal water-air and food systems, required for the cultivation of farm crops, is a guarantee of the fast mineralization of water soluble organic matter contained in waste water;

d) A sufficient period of time of 20 to 30 days is available for biochemical contamination in the use of waste water for irrigation, between the watering and the harvest. Such a period of quarantine for all farm crops (fodder and grain), meeting the regulations on irrigated farmland, has no substantial influence on crop sizes. Whereas such a period of time results in the total self decontamination of waste water released in water reservoirs, this applies even more so to irrigated farmland;

e) Outlays for the building and operation of an irrigation network are compensated by higher yields.

Reaching the soil with the waste water the organic pollutants may greatly harm the soil microflora and vegetation. It has been biologically established that the toxicity of substances is manifested through their dose or concentration. Therefore, it would be impossible to draw a line separating medicinal from toxic substances, since in insignificant amounts inhibitors act as stimulators while stimulators in excess doses have an inhibiting impact.

Certain chemical elements (arsenic, heavy metals, and polychlorine-containing organic matter) can be removed from a living organism exceptionally

slowly, for which reason they may accumulate within it. Most organic compounds, entering a living organism, leave it gradually. This occurs either as a result of their breakdown or deactivation or as a result of their removal from the organism, or through a combination of these and other methods. Such disintoxication is identically present in animals, plants, and microorganisms.

Whereas the basic rules governing metabolism and disintoxication in the living organism in the soil have been sufficiently developed, such development in terms of plants has been developed quite recently, starting with the application of toxic chemicals in agriculture. It turned out that organic phosphorus poisons are more toxic to all biological species compared with organic chlorine poisons. The latter, however, have cumulative properties to one or another extent, whereas organic phosphorus toxins detoxify quite rapidly in the living organism. The mineral theory of plant nutrition has been universally recognized. It was the basis for the theory of plant fertilizing. In recent years information has been developed not only on detoxification but on the absorption by plants of a great variety of organic compounds. F. Nartey has reported that various plant species have effectively absorbed rather large quantities of cyanides. Marked carbon cyanide energetically participates in the metabolic process of substances of vital importance to plants. S. V. Durmishitdze and D. Sh. Ugrekhelidze have noted the active absorption by superior plant species of butane, ethane, propane, and even a chemically strong compound such as benzene. The marked carbon in these organic matters was separated from the carbon dioxide and linked with proteins and organic acids.

The studies conducted at the VNIISSV led to the determination of energetic process of decontamination of farm plants from acetaldehyde, crotonaldehyde, benzaldehyde, dichloroethane, carbon tetrachloride, methanol, ethanol, butanol, propanol, dimethyldioxane, and caprolactam. The concentration of such organic matter in irrigation water not exceeding 400 milligrams per liter has no physiological influence on plants.

Therefore, a variety of waste water polluted with organic matter could be decontaminated and used in irrigated fields.

Nevertheless, a number of difficulties remain such as the multicomponent nature of pollution in waste water and the impossibility to establish all pollutants. Therefore, presently the following system is used in determining the suitability of waste water for irrigation:

The activities of soil microflora must not be suppressed;

Groundwater must not be polluted;

Farm crop yields must be close to yields of crops irrigated with clean water;

No pathological changes must develop in animals fed over long periods of time goods grown on such irrigated areas;

The products of animals fed vegetation grown on irrigated fields must be of good quality.

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PERMISSIBLE SUBSTANCE CONTENT IN WASTE WATER USED FOR FEED CROP IRRIGATION

ISPOL'ZOVANIYE BYTOVYKH I PROM'SHLENNYKH STOCHNYKH VOD V SEL'SKOM KHOZYAYSTVE in Russian pp 47-54

[Article by Candidate of Biological Sciences B. F. Zhirnov, VNIISSV]

The soil method is one of the most effective ones for the treatment of waste water against pollution. Extensive practical experience has indicated that some waters, particularly industrial and residential effluents, and the waste water of livestock farms and a number of enterprises could be successfully used for the irrigation of farm crops. In the course of the process crop yields arise and pollutants are removed from the water.

Microorganisms perform the main operation in the process of the self-purification of soils from pollution. This is determined by their variety, size, and multiplication speed. However, the plants grown on fields irrigated with waste water as well must enter in contact with substances not inherent in the rewquirement norms of the organism, i.e., not necessary for the normal growth and development of the plant. As a result of nonmetabolic absorption such substances penetrate into the plant and are either metabolized or removed from the system. In other words, self-treatment processes occur in the plants as well.

However, the capacity for self-purification of both the soil and the plants is not unlimited. Therefore, far from all waste water could be used for irrigation. It is precisely this that determines the need for establishing the maximal content of the individual substances in irrigation water.

A number of methods have been proposed concerning irrigation assessment of natural waters, based on practical tolerance norms for one or another salt contained in the water. No such methods have been developed as yet for waste water. This necessitates the use of methods of irrigation assessment of natural waters, taking into consideration the fertilizing value of waste water and the properties of the substances it contains not considered necessary to maintain plant life. We have also been short of approved normative documents indicating maximum permissible concentrations (MPC) of individual substances in waste water used for irrigation.

Extensive work has been done in the USSR and abroad on the utilization of waste water for irrigation. A number of works provide data on the concentration of individual substances in waste water. In 1965, using domestic research data, N. I. Khlebnikov offered a list of permissible concentrations of ingredients in waste water and conditions governing their utilization in agriculture. M. F. Budanov compiled a more extensive table which included MPC for 18 separate components of waste water used for irrigation. The consolidated report of the conference of heads of water resource authorities of CEMA-member countries (1973) listed data on permissible concentrations of individual chemical pollutants in waste waters used for irrigation in the GDR, and temporary MPC used in Poland.

It should be noted that the determination of MPC in water used for other purposes (such as, for example, household water utilization and fish breeding water reservoirs) is based on the stipulation that such substances are always present in the water reservoir. However, in our view, this approach is unacceptable for determining the MPC of toxic agents in irrigation water, since after each watering the soil microflora and the vegetation seem to experience in terms of pollution a periodical shock load which declines with the development of detoxification processes after watering.

Obviously, establishing the MPC of toxins in irrigation water we should recommend concentration whose use would guarantee the total decontamination of the plants for the period from the last watering to their utilization (mowing, grazing, harvesting). The existing rules governing the use of irrigated fields stipulate that an interval of no less than 14 days must be maintained from the last watering to the harvesting of fodder crops, or an interval of no less than 20 days between the watering and the grazing. Under such circumstances the MPC for toxins could be higher than, for example, for household use of nondrinking water.

Naturally, under experimental conditions, i.e., the types of vegetation and weather conditions, soil types and hydrogeological conditions, and the level of irrigation norms and frequency could substantially influence the development of detoxification processes in the soil and the vegetation. The lack of a single standardized method for determining the MPC of toxins in the water used for irrigation also leads to conflicting data found in different works.

All this leads to the difficulty of comparing the results achieved by different researchers. Currently, however, when waste water is being used to an ever greater extent for irrigation purposes the determination of MPC for individual chemical pollutants in such waters becomes an adamant necessity.

The present article contains a classification of available published data with a view to the formulation of norms for the maximum content of the individual substances in waste water used in fodder crop irrigation.

General Concentration of Matter in Irrigation Water

Currently most investigators have already abandoned the idea that high salt concentrations have an oppressing influence on plants as a result of the high osmotic pressure of the external solution. Within the range of concentration of interests to agronomy, the main factor which determines the salt resistance of plants and salt toxicity is not the osmotic pressure of the outside solution but the type of ion.

Academician I. S. Rabochev points out that collector-drain and groundwaters with a salt content not exceeding 5 grams per liter could be used for washing saline and strongly salinized land and for the irrigation of rice and fodder crops under different land reclamation conditions.

G. S. Nesterovia's survey cites data on foreign experience in the utilization of mineralized and sea waters for irrigation. It is stated, in particular, that a 7-year study conducted in Tunisia showed that with good draining conditions water with a 2-6 grams per liter mineralization could be used over a long period of time. The survey also describes practical experience in the use of sea water with a salt concentration of up to 40-53 grams per liter for irrigation.

Let us emphasize that frequently the insufficient consideration of the buffering power of the soil leads to the fact that the positive results obtained as a result of brief experimentation turn out unfounded when extensively applied to irrigated farming. A disparity seems to develop between the data obtained through short controlled experiments and irrigated farming practices. In our view, this has been pointed out entirely accurately by N. G. Minashin: "...It is no accident that mineralized waters have not been extensively used in the entire 5,000 years of development and improvement of irrigated farming. Within that time a number of practics have been tried yet few have been adopted."

Since irrigated fields are long-term use systems, naturally, recommendations applicable to them should give preference to long practically tested experience.

We should note that, in general, with a good draining system, water with a higher mineral content could be used. Studies conducted in the saline and sandy steppes of Central Europe proved that the salt resistance of all plants is far higher on sand and gravel than on cultivated soils containing clayey particles. Therefore, available data lead us to recommend the use of waste water with a salt content not exceeding 5 grams per liter in light soils.

Nitrogen-Containing Substances

The use of fertilizers, nitrogen-containing in particular, results in considerably higher crop yields. However, the application of large amounts of nitrogen fertilizers, while increasing yields, also increases the

contents of nitrates in plants and leads to their gradual accumulation in the soil and groundwaters.

Presently the accumulation of nitrates in the soil and groundwaters and plants (essentially as a consequence of the utilization of high doses of nitrogen fertilizers), initiated in the economically most developed countries, is spreading ever more extensively and is gradually rising to the scale of a global catastrophe. The struggle with this phenomenon is becoming one of the important tasks in resolving the general problem of protecting environmental purity.

According to domestic studies, the accumulation of nitrates in excess of 0.5% in feeds is already threatening the animal with intoxication. In Czechoslovakia an even lesser level -- 0.3% -- is considered critical in terms of nitrate content in feeds. In terms of nitrogen, such nitrates account, respectively, for 0.11 and 0.07%, i.e., amounts insufficiently reflecting the overall nitrogen content in plants. However, the use of feeds with a higher nitrate content leads to the formation of methemoglobin in animals. Food and water with an increased nitrate content acts similarly on humans.

In accordance with the experimental program conducted by CEMA-member countries, the influence of high doses of nitrogen on yields and quality of hay and grazing grasses and on the health condition of livestock consuming such feed was studied in Czechoslovakia over a number of years. An increase in the methemoglobin in the blood of milk cows grazing in pastures where 320 kilograms per hectare of nitrogen were applied rose to 11.1%. One-half of animals' calving was difficult. As a result of the application of 240 kilograms per hectare of nitrogen in the pasture the methemoglobin content in the blood of the calves rose during the grazing period from 0.33 to 3.35%. After the grazing the methemoglobin content in the blood of the controlled animals dropped sharply over a 1 month period. As the content of nitrates in the feed rose their harmfulness to the livestock increased. Cattle grazing in pastures with a high nitrate content in the grass could even trigger the unexpected and simultaneous death of several animals.

The various nitrates are the most widespread nitrogen fertilizers. Frequently they are found in considerable quantities in waste water used for irrigation. This as well could bring about an accumulation of nitrates in the plants. Data exist concerning other substances showing that the use of carbamide of a quantity equivalent to the nitrogen content results in a lesser accumulation of nitrates in the plants.

A study of such works leads to the conclusion that with a view to obtaining high quality fodder we should limit the application of nitrogen-containing substances. Particular attention should be paid to the use for irrigation of waste water released by livestock farms, for such water always contains a high quantity of nitrogen-containing substances.

Since most nitrogen-containing substances are well assimilated by the plants application doses may be based on their general nitrogen content. The overall quantity of applied nitrogen-containing substances should not exceed 300 kilograms per hectare in which the nitrogen contained in nitrates should not exceed 200 kilograms per hectare.

Harmful Substances

The list of maximum content of substances which follows is based on studies conducted in the GDR, for that country is the most advanced in the study of this problem. The GDR has three lists of permissible concentrations of individual chemical compounds in irrigation waters, each one pertaining to its grade type of irrigation water.

The table is based on permissible concentrations for second quality grade of irrigation water which could be used with no restrictions for all field and garden crops. This list has been extended with data supplied by domestic researchers and by Polish scientists.

Maximum Matter Content in Waste Water Used for Feed Crop Irrigation

Substance	Maximum permissible concentration, mg/liter
1	2
A. General Indicators	
General matter concentration	5000 for light soils 3000 for medium light soils 1500 for heavy soils
Nitrogen-containing substances (overall nitrogen)	200-300 kg per hectare per vegetation period
Including nitrates	200 kg/hectare for vegetation period
B. Content of Individual Substances	
Ammonium	50.0
Acetone	40.0
Barium	4.0
Gasoline	0.1
Benzene	0.5
Borium	0.5
Tungsten	10.0
Detergents	30.0
DDT	0.5
Iron	20.0
Cadmium	0.2
Caprolactam	200.0
Cobalt	1.0

Magnesium	300.0	
Manganese	1.0	
Copper	2.0	
Methanol	200.0	
Methyl ether of methacrylic acid	50.0	
Arsenic	0.2	
Sodium carbonate (soda)	200.0	on nonsaline soils
	100.0	on saline soils
Petroleum	0.3	
Nickel	0.5	
Nitrates	200.0	
Nitrites	0.5	
Acrylic acid nitryl	100.0	
Rhodanines	2.0	
Lead	0.1	
Selenium	0.05	
Vegetal resins	5.0	
Sulfates	500.0	
including:		
cobalt sulfates	2.0	
copper sulfate	7.0	
Phenol	40.0	
Formaldehyde	50.0	
Chloride	300.0	
Chromium (YI)	0.05	
Cyanide	0.01	
Cyanic compounds (other than KCN)	10.0	
Potassium cyanide (KCN)	0.2	
Zinc	2.0	

Notes: 1. In the presence of considerable amounts of one of the basic nutritive elements in the water (NPK) the remaining elements must be applied in order to create the optimal crow-growing ratio for NPK.

2. With a good draining system the irrigation water may contain a higher content of some organic matter. In each case, however, it requires additional studies.

Naturally, we cannot claim that the chemical study of waste water and the data of the table on the maximum content of substances should enable us to draw definitive conclusions on the suitability of waste water for irrigation. Usually waste water is a complex multicomponent system. This determines the possibility for both increasing and reducing the influence of individual components on the plants as a result of their interaction which, in turn, considerably depends on the concentration ratio of individual components.

The complete chemical analysis of waste water is rather complex and labor-intensive. Presently it is practically impossible to analyze everything and to establish the MPC for all substances. Thus, available data show that tobacco smoke contains over 800 substances, This fact was established as a result of tremendous analytical work. Yet the list of MPC of harmful substances in water used for nondrinking household purposes, issued in 1973 by the USSR Ministry of Health, contains no more than 420 names of harmful substances. Yet this list is the result of the work of many laboratories in many institutes over a number of years. Therefore, so far, the final word is that of direct biological experimentation in resolving the problem of the applicability of waste water to any irrigation project.

It is to be hoped, however, that the suggested list for the maximum content of substances could be used for the orientational assessment of the suitability of waste water for irrigation.

UDC 628.3+631.67+633.2

INFLUENCE OF TIME VARIANT NONVEGETATION WASTE WATER IRRIGATION ON PERENNIAL GRASS YIELD

VLIYANIYE RAZLICHNYKH SROKOV VNEVEGETATSIONNOGO POLIVA STOCHNYMI VODAMI NA UROZHAY MNOGOLETNYKH TVAR in Russian pp 82-90

[Article by Candidate of Agricultural Sciences N. A. Kovaleva and Engineer G. Yu. Kurdenko (VNIISSV)]

The growing of perennial grasses is most effective from the farming and sanitation viewpoints on fields irrigated with waste water. It has been established that the best solution of water preservation problem is achieved through the year-round utilization of waste water. Presently year-round systems have been developed in some oblasts in the USSR and in a number of foreign countries.

Systems have been developed in which in the nonvegetation period the waste water is accumulated in a storage tank, after which, during the vegetation period, the entire amount is used for irrigation. Systems have been developed according to which the reception and distribution of a certain amount of water is accomplished directly in the fields on a year-round basis.

The idea of using the winter period for land irrigation was formulated by M. M. Krylov as early as 1931. Winter irrigation of spring wheat and potatoes in droughty areas yielded good results [6].

Winter irrigation with clean water is known as water supply irrigation. However, the influence of winter irrigation is not restricted merely to water supply, for it regulates soil moisture and thermal exchange and has a beneficial influence on fertility and yields. Available data show that such irrigation substantially influences the distribution of nutritive substances in the soil and the development of the root system ([1, 6, 7, 11]. It has been equally pointed out that perennial grasses are very responsive to water supply irrigation.

Of late meadow winter irrigation has been used more extensively. Thus, starting with 1963, the Zhana-Semeyskiy Sovkhoz in Semipalatinskaya Oblast, has irrigated meadows in winter with clean water. A 25 to 50 cm water stratum

was frozen above the meadow. Meadow winter irrigation changed qualitatively the grass structure: following winter irrigation poor sheep's fescue was replaced by valuable grasses (awnless bromegrass, June grass, yellow lucerne, and pink and blue coronilla). Hay crop yields rose from 4-6 to 24 quintals per hectare while production costs dropped 300% [2].

The effectiveness of winter meadow irrigation depends on soil and weather conditions, and the grass structure and winter hardiness. I. P. Tumanov pointed out that under natural conditions grass winter hardiness is affected by its age, wintering period, and supply of nutritive substances. The existence of an adequate amount of phosphorus and potassium in the second half of the vegetation period contributes to a better wintering. Grass wintering largely depends on the accumulation of carbohydrate reserves. Spring time conditions and grass resistance to flooding greatly influence its survival. It has been established that the maximum flooding with spring floodwaters is as follows (in days): awnless bromegrass, 26-23; wheat grass, 31-35; timothy grass, over 50; canary grass, 40-50; bentgrass, 24-35; sweet clover, 10-12; and alfalfa, 10-14 [10].

In the year-round utilization of waste water problems related to the extra vegetational (including the winter) irrigation of perennial grasses are particularly important. Responsive to waste water irrigation, perennial grasses increase their yields drastically, while the sod and the thick root system increase the level of water purification. Year-round, including winter, irrigation improves the conditions governing the acceptance and utilization of waste water. Furthermore, extraseasonal irrigation, particularly winter irrigation, develops new ecological conditions for the survivability of grasses and their growth and development. The possibility to use waste water in grass irrigation was established by K. V. Yeremeyev in 1940. Subsequently, no more detailed studies were made on this subject, and winter grass irrigation was not used [4].

In 1962 V. A. Parnyakov and I. V. Sinitsina proved that with winter waste water irrigation in the conditions of Moscow Oblast the grass does not perish. However, the botanical grass structure changes. Awnless bromegrass, English bluegrass, and timothy grass proved to be the hardiest [3, 8, 9].

Starting with 1957 the VNIISSV undertook the study of the influence of systematic irrigation with waste water on perennial grass fields on sandy loam soils under Moscow Oblast conditions [5]. It was determined that winter irrigation increases soil fertility and more than doubles perennial grass fields compared with unirrigated areas, and increases yields by 18-20% compared with sectors irrigated during the vegetation period only. In the year-round (including winter) irrigation with waste water the protein and ash content in the grasses increases [5]. It was also noted that the survivability of the grasses and their growth and development largely depend on irrigation times in the nonvegetation period and on the weather conditions during irrigation.

Studies to determine the most efficient times for irrigation in the nonvegetation period were undertaken in 1972 at experimental sectors of the VNIISSV experimental farm. The sector's soils were soddy-podzolic and sandy loam. Groundwater flows at a depth of 8-10 meters and the natural drainage is good. The waste water of the Kupavna settlement and the fine woolen fabric factory was used for irrigation. The content of nutritive substances in the water was the following: nitrogen, 40-60 mg per liter; phosphorus, 8-10; potassium, 10-12; calcium, 40-50 mg per liter; the pH was 7.0-7.2; the water temperatures were 18-20°C in summer and 14-16°C in winter.

Experiments were also made at production fields and an experimental plot using the following systems on an experimental-production plot of 2.1 hectares:

Waste water vegetation irrigation;
Waste water vegetation irrigation plus winter irrigation in January;
Waste water vegetation irrigation plus winter irrigation in February;
Waste water vegetation irrigation plus winter irrigation in March;
Waste water vegetation irrigation plus winter irrigation in December.

The area was divided into 0.45 hectare sections. The grass mixture consisted of (in %): awnless bromegrass (37), meadow foxtail (16), June grass (25), timothy grass (7) and mixed fodder plants. These grasses are essentially winter hardy and can withstand extensive flooding. The same system was applied on the experimental lot. However, a control variant was added irrigated with clean water during the vegetation period.

All variants for the vegetation irrigation were based on an identical irrigation system (maintaining soil moisture within the 60-70% maximum field moisture soil capacity), which called for 8-10 50-60 mm irrigations. Irrigations in the nonvegetation period were conducted on a one-time 200-mm norm in the period we mentioned. Flood irrigation was used using flexible valve equipped capron hose.

Particular attention was paid to the observation of meteorological conditions in winter irrigation. The results of the observations are presented in Table 1. It shows that in the nonvegetation irrigations the irrigation water temperature ranged between 10 and 16°C; the air temperature was quite different according to the month and was the lowest (as low as -25°C) in January throughout the experimental period. The snow blanket thickness also varied by year, ranging from 8 to 38 cm in January, from 23 to 40 cm in February, and from 8 to 43 cm in March. The depth of freezing of the soil differed considerably, ranging for the 3 years 60-78 cm in January and 62-137 cm in February and March. In 1972-1973 the February and March freezing depth was merely double that of 1974. At a 20-cm depth the soil temperature during the irrigation periods showed insignificant differences in terms of variant and year. In January 1972 and 1973 icing up to 20 cm thick developed after irrigation; up to 5 cm developed in February 1973, and there was no icing in 1974. There was no spring accumulation of waters in the plots. There were no variant differences at the beginning of the sprouting and field work seasons.

The observations indicated that the nature of the moisture breakdown in depth in the variants involving nonseasonal irrigations was the same as without irrigation: moisture stocks increased along the entire depth from October to January; in February and March they rose primarily in the upper stratum; toward April moisture reserves reached their autumn levels. Therefore, irrigation in the nonvegetation period does not affect the size of the introduced moisture stock and toward the end of April irrigation becomes necessary.

At the experimental plots the grass green mass harvest took place during the flood-formation and blooming periods. At the production plot the grasses were mowed and the green mass was simultaneously crushed with a KIK-1.4 machine; the mass was then processed into grass meal with the AVM-0.4 system. There were three mowings in all. The data on the green mass and dry substance yields by mowing and variant, shown on Tables 2 and 3, point out the following:

Perennial grass yields under waste water irrigation in drought years rise 4.5 times, averaging 2.0-2.5 times in years of average moisture.

In vegetation irrigation with waste water grass yield in 1972-1974 averaged 29.3% higher than in vegetation irrigation with pure water.

In a combination of waste water irrigatio in vegetation and nonvegetation periods and at experimental-production and experimental plots grass yields were 3-15% higher trhan in vegetation irrigation only.

The highest yield increase (up to 8-15%) was obtained in variants in which summer irrigations were combined with December and March irrigations.

With February irrigations grass yield increases varied by year: in the warmer 1973 they reached 10-11%; in the colder 1972 they were 4.5% below than at sectors subjected to seasonal vegetation irrigation only.

During years with low air temperatures, thin snow blanket, and deep soil freezing (1972 and 1974) January irrigation in both plots lowered yields by 5-8% compared with the variant without nonvegetation irrigation.

In a year of softer weather conditions (1973) January irrigation had no adverse effect on grass yields compared with vegetation period irrigation. However, in order to retain the high productivity of the grass it would be better to have January waste water irrigation of grazing land or sectors allocated for preceding, or else channeled water into a container. In such natural conditions December, February and March irrigations are quite expedient: they increase grass productivity and contribute to the better distribution of waste water in the nonvegetation period.

Table 1

Observation Results in Perennial Grass Irrigation in the Nonvegetation Period of 1972-1974 at the Experimental-Production Plot

Т а б л и ц а I

Результаты наблюдений при проведении поливов многолетних трав во вневегетационный период I972-I974 гг. на опытно-производственном участке

(1) Варианты зимних поливов	(3) в декабре	в январе (4)			в феврале (5)			в марте (6)		
(2) Дата поливов	I973 (26/XII)	I972 (I8/I)	I973 (24/I)	I974 (26/I)	I972 (23/II)	I973 (I2/II)	I974 (2I/III)	I972 (3/III)	I973 (I2/III)	I974 (20/III)
(7) Мощность снежного покрова, см	3,0	25,0	8,0	42,0	22,0	34,0	40,0	5,0	40,0	33,0
(8) Среднесуточная температура воздуха в день полива, °C	-0,I	-20,I	-25,I	-II,9	-2,5	-7,2	-8,I	-0,2	-6,2	+2,6
(9) Среднесуточная температура почвы в день полива на глубине 20 см, °C	-0,5	-	-2,2	-2,8	-	-0,4	-0,2	-	-0,I	-0,2
(10) Температура поливной воды, °C	I0,0	+I6,0	+I0,0	+I2,0	+I6,0	+I3,0	+I0,0	+I6,0	+I5,0	+I2,0
(11) Глубина промерзания почвы до полива, см	0,3	78,0	94,0	75,0	I22,0	I25,0	60,0	I36,5	I08,5	54,0
(12) Естественное оттаивание почвы в день полива, см	0,0	0,0	0,0	0,0	0,0	0,I	0,0	5,0	0,0	25,0
(13) Мощность наледенения после полива, см	0,0	20,0	9,0	0,0	0,0	5,0	0,0	0,0	0,0	0,0
(14) Весенний запас влаги, м³/га	I900		I980	I400		2000	I600		2I20	I500
(15) Весенний запас влаги, м³/га, на варианте без зимних поливов									I970	I500

Key:

1. Winter irrigation variants
2. Irrigation date
3. December
4. January
5. February
6. March
7. Snow blanket thickness, cm
8. Average daily air temperature, the day of irrigation, °C
9. Average daily temperature on the date of irrigation at 20-cm depth, °C
10. Irrigation water temperature, °C
11. Depth of soil freezing prior to irrigation, cm
12. Natural soil precipitation on day of irrigation, cm
13. Icing thickness after irrigation, cm
14. Spring moisture stock, cubic meters per hectare
15. Spring moisture stock, cubic m per hectare in the variant without winter irrigation

Table 2

Perennial Grass Yields at the Experimental-Production Plot, quintals per hectare

Таблица 2

Урожай многолетних трав на опытно-производственном участке, ц/га

Варианты (1)	1972 г.		1973 г.		1974 г.		В среднем за 3 года (4)	
	зеленая масса (2)	абсолютно сухое в-во (3)	зеленая масса (2)	абсолютно сухое в-во (3)	зеленая масса (2)	абсолютно сухое в-во (3)	зеленая масса (2)	абсолютно сухое вещество (3)
(5) Вегетационные поливы	243,5	55,0	408,0	92,6	5II,3	II3,9	388,0	87,5
(6) Вегетационные поливы+ вневегетационный полив в январе	205,4	43,0	305,0	63,5	408,2	90,4	306,2	65,6
(7) Вегетационные поливы+ вневегетационный полив в феврале	225,5	45,8	458,0	I00,9	467,5	I04,0	387,0	83,8
(8) Вегетационные поливы+ вневегетационный полив в марте	256,0	53,6	470,0	98,5	535,0	II8,6	4I8,0	90,2
(9) Вегетационные поливы+ вневегетационный полив в декабре					540,0	I20,3		

Key:
1. Variant
2. Green mass
3. Absolute dry matter
4. 3-year average
5. Vegetation irrigation
6. Vegetation irrigation plus nonvegetation irrigation in January
7. Vegetation irrigation plus nonvegetation irrigation in February
8. Vegetation irrigation plus nonvegetation irrigation in March
9. Vegetation irrigation plus nonvegetation irrigation in December

Table 3

Perennial Grass Yields at the Experimental Plot, quintals per hectare

Т а б л и ц а 3

Урожай многолетних трав на деляночном опытном участке, ц/га

Варианты (1)	1972 г.		1973 г.		1974 г.		В среднем за 3 года (4)	
	зеленая масса (2)	абсолютно сухое в-во (3)	зеленая масса (2)	абсолютно сухое в-во (3)	зеленая масса (2)	абсолютно сухое в-во (3)	зеленая масса (2)	абсолютно сухое в-во (3)
(5) Контроль без орошения	41,2	9,2	209,3	48,6	375,0	110,2	208,5	52,6
(6) Летние поливы	243,0	45,6	516,0	113,1	600,0	138,2	486,0	98,8
(7) Летние поливы+зимний полив в январе	212,0	44,0	519,0	114,1	576,0	147,3	435,0	102,2
(8) Летние поливы+зимний полив в феврале	234,0	46,4	572,0	121,0	568,0	122,3	458,0	96,2
(9) Летние поливы+зимний полив в марте	276,0	57,4	484,0	106,3	660,0	159,7	474,0	107,5
(10) Летние поливы+зимний полив в декабре	нет(12)	нет(12)	нет (12)	нет (12)	592,0	146,0	–	
(11) Летние поливы чистой водой	122,0	24,7	381,0	87,1	461,0	111,7	321,0	76,4

Key:

1. Variant
2. Green mass
3. Absolute dry matter
4. 3-year average
5. Control without irrigation
6. Summer irrigation
7. Summer irrigation plus winter irrigation in January
8. Summer irrigation plus winter irrigation in February
9. Summer irrigation plus winter irrigation in March
10. Summer irrigation plus winter irrigation in December
11. Summer clean water irrigation
12. None

BIBLIOGRAPHY

1. Грамматикати О.Г., Петров Е.Г. Влагозарядочное орошение. М., 1963.
2. Грицай Н. Зимние поливы. М., 1965.
3. Канардов И.П. Орошение сточными водами. Диссертация на соиск.ученой степени канд.с.-х. наук. Москва, 1946.
4. Канардов И.П., Еремеев К.Е. Орошение сельскохозяйственных культур сточными водами. М., 1943.
5. Ковалева Н.А. Использование сточных вод тонкосуконного производства для орошения кормовых культур на супесчаной почве. Диссертация на соиск.ученой степени канд. с.-х.наук, Москва, 1966.
6. Крылов М.М. Зимнее орошение с намораживанием льда для резкого повышения урожая картофеля на юге. - "Почвоведение", 1954, № 7.
7. Мажаров П.П. Зарядковое орошение. М., 1952.
8. Парняков В.Л. О зимнем поливе сточными водами сенокосно-пастбищных угодий. М., 1965.
9. Синицин Н.В. Влияние сточных вод на урожай кормовых культур. Диссертация на соиск.ученой степени канд. с.-х.наук Москва, 1965.
10. Туманов И.П. Зимостойкость сельскохозяйственных культур. М., 1940.
11. Шубин В.Ф. Влагозарядочное орошение. М., 1952, 1958.

UDC 628.3+631.41+631.826

EFFECTIVENESS OF APPLICATION OF ORGANIC AND MINERAL FERTILIZERS DURING WASTE WATER IRRIGATION

EFFEKTIVNOST'VNESENIYA ORGANICHESKIKH I MINERAL'NYKH UDOBRENIY PRI OROSHENII STOCHNYMI VODAMI in Russian pp 90-94

[Article by Candidate of Agricultural Sciences V. V. Ignatova (VNIISSV) and Engineer V. V. Baykov (Noginskiy Sovkhoz)]

The waste waters used for irrigation may contain different quantities of nutritive substances. I. P. Kanardov [1] writes that the NPK ratio in waste water is usually 5:1:2, whereas the optimal ratio of such nutritive substances for plants averages 2.5:1:2.3 according to D. N. Pryanishnikov. Consequently, soil irrigated with waste water becomes enriched, first of all, with nitrogen. It would be expedient to compensate for phosphorus and potassium shortages through the additional application of fertilizers. The nutritive substances which enter the soil with waste water are used differently by the different soils. The nutritive substances are utilized most fully in the course of the seasonal irrigation of soils possessing good absorption capacity. Soils with a low absorption capacity such as sandy and large grained soils with small quantities of organic substances have a low coefficient of utilization of nutritive substances. On such soils extensive sprinkling and irrigation norms are frequently paralleled by losses of nutritive substances. Peat, compost, manure and others applied to the soil raise the utilization coefficient of nutritive substances entering the soil with the waste water. A great variety of conflicting data exist on the utilization coefficient of nutritive substances in irrigated fields. For example, at communal irrigated fields with an annual utilization of waste water per unit area ranging from 10,000 to 25,000 cubic meters per hectare, and a considerable denitrification and extensive seepage of irrigation water in the ground water the plants' utilization coefficient is 0.5 for nitrogen, 0.95 for phosphorus, and 0.7 for potassium [2].

Losses of nutritive substances occur also in irrigated fields using higher sprinkling and irrigation norms or where waste water is unevenly distributed. Where such water accumulates a considerable percentage of the nutritive substances, nitrogen above all, seeps into the ground waters. Such losses of nutritive substances could be reduced through the proper organization

or irrigation and water distribution. In terms of nutritive content, waste water is fertilizing. However, the additional application of organic and chemical fertilizers upgrades the effectiveness of its utilization. This problem was studied at the Noginskiy Sovkhoz, Moscow Oblast, and at the experimental farm of the VNIISSV.

The residential waste water of the neighboring settlement was used for irrigation. One liter of waste water contained the following: from 59 to 156 milligrams general nitrogen; 13.6-47 milligrams P_2O_5; 16.2-38.5 milligrams K_2O; 83.5-155.0 milligrams Ca+Mg; the pH was 6.5-7.1. The amount of water per sector was determined through control measurements of debits and length of water supply.

The study of waste water indicated a relative shortage of nutritive substances. The need arose, therefore, for field experiments to determine the effectiveness of organic and chemical fertilizers in a waste water irrigation system.

The soils of the experimental sector of Noginskiy Sovkhoz -- consisting of light soddy-underpodzolic sand -- have a bulk density of 1.5-1.72, and a density of 2.5-2.67 grams per cubic centimeter. The filtration coefficient of these soils is 10 meters per 24 hours. The sector is well drained and has a discharge of ground waters located at a depth of 9.33 meters (square No 269). The chemical analysis of the soils of the irrigated section is given in Table 1.

Table 1

Agrochemical Characteristics of the Soil of the Experimental Section (Noginskiy Sovkhoz)

Depth of soil sample, cm	pH of salt extract	Humus according to Tyurin, %	Total absorbed foundation, mg equiv to 100 gr soil	Hydrolytic acidity, mg equiv to 100 gr soil	Mobile forms, mg per 100 grams of soil	
					K_2O	P_2O_5
0-20	5.7	2.53	20.0	2.7	9.2	7.0
30-40	6.1	0.56	6.4	-	7.7	7.0
40-50	4.9	0.63	5.6	-	7.0	5.0
50-75	4.2	0.17	-	-	-	5.0

Despite the low effective and potential fertility, sandy soils have favorable thermal characteristics and good aeration, and yield to cultivation quite rapidly. The need for additional application of organic and chemical fertilizers in year-round irrigation with waste water was studied in accordance with the following system:

Control without irrigation and fertilizing;

Control -- irrigation with industrial and residential waste water;

Manure 40 tons per hectare + irrigation with industrial-residential waste water;

Peat 40 tons per hectare + irrigation with industrial-residential waste water;

$N_{80}P_{100}K_{100}$ + irrigation with industrial and residential waste water;

$N_{80}P_{100}$ + irrigation with industrial-residential waste water;

N_{80} + irrigation with industrial and residential waste water;

P_{100} + irrigation with industrial-residential waste water;

K_{100} + irrigation with industrial and residential waste water.

The irrigation was made with a 60% maximum soil moisture capacity. The crop was the Krasnodarskiy 1/49 corn strain. Chemical fertilizers were applied during the spring plowing. The amount of fertilizer to be applied per lot was computed by the formula:

$$y = \frac{d.S \cdot 100}{P},$$

in which d is the dose of fertilizer in active matter per hectare, in kg; S is the lot size in square meters; and P is the content of active substance in the fertilizer, in percentage.

The experiment was repeated three times on 300-312 square meter lots. The crop was estimated on the basis of the continuous method.

At the same time organic fertilizer (manure and peat) was applied with manure spreaders mounted on a Belarus' tractor.

The autumn plowing of the section was 22-23 centimeters deep; the early autumn plowed field was harrowed in early spring, followed by a replowing at a 20-22 centimeter depth with the application of fertilizers based on the experimental system with presowing leveling of the soil with a cultivator. The corn was planted with a SKPN-8 drill with a density of 30 kg per hectare. In the vegetation period irrigation and a single application of herbicides was followed by interrow cultivation. The resulting data indicated that the additionally applied organic and chemical fertilizers were highly effective with waste water irrigation (Table 2).

Table 2

Influence of Organic and Chemical Fertilizers in Waste Water Corn Crop Irrigation
(2-year average)

Variants	Yield, quintals per hectare	Additional yield and control with waste water irrigation with 60% maximum soil moisture: quintals per hectare	%
Control without irrigation and fertilizing	154.1	-	-
Control with irrigation with 60% of maximum soil moisture	274.6	-	-
Manure 40 tons + irrigation with 60% of maximum soil moisture	432.1	157.5	57
Peat 40 tons + irrigation with 60% of maximum soil moisture	357.8	101.2	36
$N_{80}P_{100}K_{100}$ + irrigation at 60% of MSM	345.4	70.8	25
$N_{80}P_{100}$ + irrigation with 60% MSM	295.5	21.0	7
N_{80} + irrigation with 60% MSM	282.9	8.3	3
K_{100} + irrigation with 60% MSM	208.1	50.0	13.6
Experiment accuracy, %		2.67	
Least essential disparity ($LED_{0.95}$)		19.836	

Similar studies were made at the experimental sector of the VNIISSV with the irrigation of potatoes with the waste water of a fine woolen cloth factory. The following alternatives were studied:

Control without irrigation;

Control with water supply irrigation averaging 3,000 cubic meters per hectare;

Control with vegetational irrigation of 600 cubic meters per hectare;

Application of peat, 50 tons per hectare, with water supply irrigation of 3,000 cubic meters per hectare;

Application of 50 tons per hectare of peat + $N_{90}P_{40}K_{90}$ + water supply irrigation of 3,000 cubic meters per hectare.

The experimental lots averaged 250 square meters and the experiment was repeated three times.

The studies indicated that the additionally applied fertilizers increased potato yields. Thus, the yield averaged 143.6 quintals per hectare with irrigation with waste water and application of 50 tons per hectare of peat + $N_{90}P_{40}K_{90}$. At the control plot irrigated with the same amount of waste water (76.6 quintals per hectare), with the application of total chemical fertilizer of $N_{90}P_{40}K_{90}$ the potato crop averaged 137.7 quintals per hectare, or was 61.6 quintals above the control figure.

The additionally applied organic and chemical fertilizers, with waste water irrigation would be economically justified: production cost per quintal of grain mass of corn without irrigation equalled 1.22 kopeks; with irrigation without fertilizer, 0.83; and with additional application of 40 tons per hectare of manure, 0.86 kopeks; of peat, 0.87 kopeks; and $N_{80}P_{100}K_{100}$ -- 0.70 kopeks.

The high effectiveness of the additional application of organic and chemical fertilizers in irrigation with waste water is based not only on the content of their nutritive substances but their favorable impact on the soil structure. Furthermore, the application of manure and peat improves the aeration system of the soil which is very important for the decomposition of the organic matter which penetrates with the waste water.

BIBLIOGRAPHY

1. Канардов И.П. Некоторые особенности поливного режима на земледельческих полях орошения. М., 1965.
2. Савостьянов П.С. Поля орошения и поля фильтрации. М., 1937.

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OPTIMIZING BOCS POND CONSTRUCTION

OB OPTIMIZATSII STROITEL'STVA BOKS PRUDOV in Russian pp 99-104

[Article by Candidate of Technical Sciences B. T. Yur'yev, and Junior Scientific Associate N. I. Mordvintseva (VNIISSV)]

The studies of biological oxidation contact stabilization (BOCS) ponds conducted under Central Asian weather conditions indicated the high effectiveness [2-4, 6,7]. The results of extensive studies of the purification of waste water in BOCS ponds were reflected in the "Provisional Recommendations" [1] according to which the BOCS ponds in Central Asia consist of eight rectangular sections with separate water inlets and outlets; the volume of each section is sufficient for containing the daily waste water outlay. The overall stay of the waste water in the section is determined with the following equation:

$$T = t_1+t_2+t_3, \qquad (1)$$

where t_1 is the filling time equal to 24 hours; t_2 is the exposure time determined by the period of destruction of over 99% of the Bacillus coli group, requiring 6 days under Central Asian weather conditions. After that period the pathogenic microflora is no longer present in the decontaminated water; t_3 is the draining time equalling 24 hours.

The number of sections equalled the overall time of stay of the water within each section. With a low amount of waste water coming from the settlement, sections may be built for two, three or more days of filling, which is economical as it lowers the number of sections and, consequently, the length of dikes, of inlet and outlet pipes, number of water intakes and releases, and so on. This makes central the task of determining the economic optimum for a longer filling time (t_1). The following formula is suggested in determining the number of sections needed for the various values of t_1:

$$n = 1+\frac{t_2+t_3}{t_1} \qquad (2)$$

The figure is rounded to the next higher number. Different t_3 may be possible for identical values of t_1. This formula enables us to determine the highest value for t_3 which lowers the cost of the draining pipeline and of the outlets by reducing the diameters.

The capital costs of BOCS pond building consist of outlays for the building of dikes and bottoms, pipe connections, installation of water inlets and outlets, and others:

$$S=PS_1+V_bS_2+L_1S_3+L_2S_4n(S_5+S_6), \tag{3}$$

where P is the dike's perimeter; V_b is the volume of removed earth; L_1 and L_2 are the lengths of the intake and outflow pipes; n is the number of sections; S_1 is the general cost per meter dike; S_2 is the cost per cubic meter excavation; S_5S_6 are the costs of water inlets and outlets.

The building of BOCS ponds using the half-excavation and half-diking system is efficient. They must be built in such a way that the entire amount of excavated soil is used in building the dike.

Geometrically, each section is shaped as an obelisk. However, the formula for computing the volume of the obeliks is cumbersome and inconvenient. It would be expedient to compute the volume of the section on the basis of an average parallelepiped whose height equals that of the section and whose sides are one-half the sizes of the lower and upper ends of the BOCS pond sections. In the case of higher daily outlays the volume is determined on the basis of an average parallelepepiped according to the rules; for small volumes we take into consideration the error. The volume, as computed according to the obelisk formula equals

$$V=h[ab+mh(a+b)=\frac{4}{3}m^2h^3],$$

where a and b are the sides of the lesser base; h is the height; m is the slope.

The volume obtained according to the formula of the average parallelepiped is:

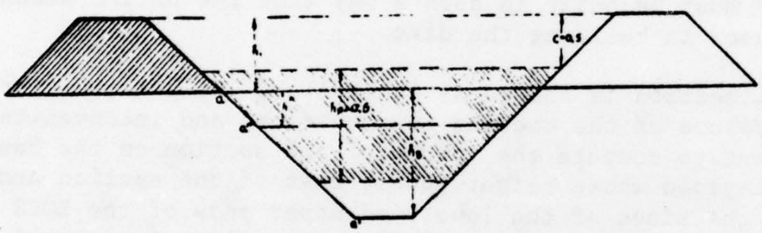
$$V'=h(a+mh)(b+mh)=h[ab+mh(a+b)+m^2h^3].$$

Let us determine the difference

$$V-V'=\frac{1}{3}m^2h^3.$$

Usually, in the building of BOCS ponds the banks (in Ordzhonikidzeabad, Talsy, the Dreverna fish breeding farm, and so on) are maintained in the 1:2 ratio. In such cases the error equals $4/3\ h^3$. In a 0.6 meter height the error per section for an outlay of 20 cubic meters per 24 hours is

1.44%; for an outlay of 5000 cubic meters per 24 hours it is 0.0057%. Clearly, such disparities could be ignored. The figure shows the crosscut of one of the sections; the shaded part is the water-filled volume. The depth of the water stratum is marked as h_p while the water volume is indicated by Q. Knowing the volume and the height we could determine the size of the smaller side (a) of an average area rectangle (F) located at a distance of 0.45 meters from the bottom; we then compute the sides of the upper and lower foundations of the section. Since the section's F equals $\frac{Q}{h_p}$ and, on the other hand, since the average area of the section equals ka^{*2}, the result is $a^*=\sqrt{\frac{Q}{h_p k}}$. This is for a 24-hour filling time. For the time period t_1 per day the quantity of incoming water will equal Qt_1 m^3. Generally we have $a^*=\sqrt{\frac{Qt_1}{h_p k}}$; $b^*=k\sqrt{\frac{Qt}{kh_p}}$. Here h is the excavation depth; h_1 is the height of the dike; as we know, in the case of BOCS ponds, in this case $h+h_1=1.25$ m.



Cross Section of a BOCS Pond Section

Let us calculate the dike volume: $V_g = P\omega$,

where P is the perimeter, ω is the cross section area

$$\omega = h,(d+mh_1);$$

in which d is the width of the dike on the ridge (in the computation d=4 m); substituting h_1 through 1.25-h, we have:

$$\omega = 2(1.25-h)(3.25-h).$$

Let us compute the dike perimeter

$$P=2n(a+2mh_1+d)+(n+1)(b+2mh_1+d)=2n(a+4h_1+4)+(n+1)(b+4h_1+4).$$

Let us express a and b through a* and b*:

$$a=a^*+2mh^*=a^*+4h^*=a^*+4(h-0.45)=a^*+4h-1.8;$$
$$b=b^*+2mh^*=b^*+4h-18 \quad =ka^*+4h-1.8;$$
$$h^*=h-0.45$$

Let us substitute a and b in the expression for the perimeter

$$P=2n(a^*+7.2)+(n+1)(ka^*+7.2);$$
$$V_g=2(1.25-h)(3.25-h)[2n(a^*+7.2)+(h+1)(ka^*+7.2)$$

and let us determine the volume of excavated earth

$$V_g=h(a^*+2h-1.8)(ka^*+2h-1.8).$$

Let us similarly determine in the function, on the basis of a* the length of inlet and outlet pipes

$$L=n(a^*+7.2).$$

Therefore, overall cost formula will be

$$S=PS+nV_g S_2+L(S_3+S_4)+n(S_5+S_6)=[2n(a^*+7.2)+(n+1)X(ka^*+7.2)]S_1+nh(a^*+2h-1.8)$$
$$(ka^*+2h-1.8)S_2+(a^*+7.2)X(S_3+S_4)+n(S_5+S_6).$$

The base of such a section is a rectangle with sides a and ka. The configuration of pond systems is essential in terms of their structure. Usually biological ponds are rectangular with a side ratio of 1:1.5 and 1:2 [5]. It is expedient to establish the type of K configuration coefficient in which the cost of BOCS ponds would be minimal. To this effect let us differentiate the cost expression according to K and make the derivative zero. The following expression will result:

$$K = \frac{2S_1n+nh(2h-1.8)S_s+n(S_3+S_4)}{S_1+(n+1)+nh(2h-1.8)S_2}.$$

On the basis of these formulas, using the weather conditions of Central Asia as an example, a program was drawn up according to which the volume of excavation, the volume of the dike, and the optimal K were computed for the various values of h($0\leq h\leq 1.25$) with a 0.05 meter interval. h and k were provided the moment the volumes were equalized. This made possible to compute the optimum excavation depth. The values of h and K for different outlays are shown in Table 1. Table 2 shows the effect of K with a productivity of 1000 and 5000 cubic meters per day.

A program was drawn up for the various outlays with different filling times with an optimum configuration coefficient. This enabled us to obtain the cost of construction of BOCS ponds. The study of such data leads to the conclusion that with outlays of up to 1500 cubic meters per day it would be expedient to build BOCS ponds consisting of two sections; with outlays of up to 5000 cubic meters per day, three sections should be built.

Table 1

Optimum Depth and Optimum Value of the Configuration Coefficient for BONDS Ponds with Different Numbers of Sections

Т а б л и ц а I

Оптимальная глубина и оптимальное значение коэффициента конфигурации для БОКС прудов с различным числом секций

Расход,м^3/сут (1)		20	50	I00	200	400	700	I000	I500	2000	3000	4000	5000
$t_1 = I$, $t_2 = I$, $n = 8$	h	I,05	0,95	0,85	0,75	0,6	0,5	0,45	0,4	0,352	0,32	0,3	0,27
	к	8	6,4	5,4	4,8	4,I	3,8	3,7	4,6	4,6	4,8	6,5	6,2
$t_1 = 2$, $t_3 = 2$, $n = 5$	h	I,0	0,85	0,75	0,6	0,5	0,4	0,35	0,32	0,3	0,25	0,22	0,2
	к	6,8	5,0	4,5	3,85	3,56	3,33	3,23	4,0	3,97	4,33	5,83	5,6
$t_1 = 3$, $t_3 = 3$, $n = 4$	h	0,95	0,8	0,7	0,55	0,45	0,35	0,3	0,27	0,25	0,2	0,I9	0,I7
	к	5,8	4,55	4,05	3,54	3,3	3,09	3,0I	3,7	3,68	4,02	5,35	5,39
$t_1 = 4$, $t_3 = 2$, $n = 3$	h	0,9	0,75	0,6I	0,5	0,4	0,35	0,3	0,25	0,2I	0,I9	0,I7	0,I6
	к	4,94	4,0	3,48	3,I9	2,98	3,28	3,I8	3,6I	4,0	3,08	4,92	5,32
$t_1 = 6$, $n_3 = 6$, $n = 3$	h	0,85	0,7	0,55	0,45	0,35	0,3	0,25	0,2	0,I9	0,I5	0,I5	0,I2
	к	4,57	3,79	3,09	2,94	2,8	2,74	2,69	3,29	3,27	3,6	4,8	4,72
$t_1 = 7$, $t_3 = I$, $n = 2$	h	0,75	0,65	0,5	0,45	0,35	0,3	0,25	0,2	0,2	0,2	0,I5	0,I5
	к	3,I7	2,95	2,69	2,98	2,98	3,23	3,I4	3,85	4,I9	4,62	6,68	7,62

Key:

1. Outlay, cubic meters per day

Table 2

Effect According to K for an 8-Section BQCS Pond for 1000 and 5000 cubic meters per day Outlays

K/Q	I000 $м^3$/сут (1)	5000 $м^3$/сут (1)
I	9823,9I	29388,I6
2	9263,48	26003,I6
3	9I28,69	248I9,70
4	9II4,63	24297,90
5	9I49,99	24066,63
6	9209,I8	23987,79
7	9280,85	23997,8I
8	9359,30	24063,30
9	944I,40	24I65,07
I0	9525,32	2429I,36

Key:

1. cubic meters per day

BIBLIOGRAPHY

I. Временные рекомендации по устройству БОКС прудов Таджикской ССР для небольших населенных пунктов. Душанбе, I97I.

2. Доливо-Добровольский Л.Б., Демин В.А., Юрьев Б.Т., Терешина А.Н. Сброс сточных вод без загрязнения водоемов. "Строительство и архитектура Узбекистана", I973, № I2.

3. Доливо-Добровольский Л.Б., Киселева Р.Н., Репко И.М., Терешина А.Н., Юрьев Б.Т. Биологическое обеззараживание городских сточных вод на контактных окислительных прудах Таджикской ССР. - Материалы научно-технической конференции в Нуреке. Душанбе, I969.

4. Доливо-Добровольский Л.Б., Киселева Р.Н., Терешина А.Н., Юрьев Б.Т. Интенсификация метода прудовой очистки в биологических контактных прудах для сооружений малой канализации в Таджикской ССР.-XXVII научно-техническая конференция МИСИ.М., I968.

5. Канардов И.П., Львович А.И., Новиков В.М., Радугин П.А. Использование сточных вод для орошения. М., "Колос", I964.

6. Юрьев Б.Т. Обработка сточных вод в контактных окислительных биологических прудах для орошения в условиях Гиссарской долины Таджикской ССР. - Труды ВНИИГиМ, т.54 (I). М., I972.

7. Юрьев Б.Т. Новые принципы расчета БОКС прудов, предназначенных для подготовки сточных вод для орошения в климатических условиях Средней Азии. - Научно-техническая конференция по использованию сточных вод в сельском хозяйстве. Ташкент, I972.

UDC 628.367

INVESTIGATION OF WASTE WATER LOAD NORMS ON DEPLETED PEAT BOGS

ISSLEDOVANIYE NORM NAGRUZKI STOCHNYKH VOD NA VYRABOTANNYKH TORFYANIKAKH in Russian pp 104-110

[Article by Candidate of Agricultural Sciences V. T. Dodolina, Engineer B. A. Buzurtanov, O. I. Skripkina, Agronomist V. A. Kuznetsov, Engineer T. I. Popova (VNIISSV)]

It has been determined by many scientists that an intensive development of physical, chemical, and biochemical processes takes place in the soil in land drainage, as a result of which the drainage water removes from the soil stratum organic compounds, calcium, sulfates, and nutritive substances. The extent of the removal depends on weather conditions, time of year, type of soil, type of crop, and other factors. An interesting pattern has been established: perennial grasses reduce the removal of water soluble salts compared with other crops. Many researchers have noted that calcium is the element removed in the greatest amounts with drainage waters, followed by magnesium and by sulfates. Potassium, sodium, and nitrogen compounds are removed in lesser amounts.

We made a lysimetric study with a view to determining differences in the removal of salts in the utilization of waste and pure water for irrigation: we took 6 lysimeters (2 groups, 3 pieces each) covering an area of 500 square centimeters and 50 centimeters high each. We put in the lysimeters peaty gley soil taken from the experimental plot, in accordance with the genetic composition. Natural soil density was achieved, after which volume weight totaled 0.16 tons per cubic meter. The irrigation norm was based on 700 cubic meters per hectare. We ran through the first group of lysimeters Nos 1, 2, 3) distilled and, through the second group (Nos 4, 5, 6) waste water. In other words, in both variants the experiment was tripled. The filtrates obtained were analyzed by basic physical and chemical indicators. The analysis data (Table 1) show that the composition of the lysimetric waters obtained with the application of waste and clean water on peaty soil was similar. In both cases we noted a substantial washing of calcium and magnesium salts. Phosphorus combinations were not flushed. Organic substances were removed in nearly identical amounts. We noted an oxidizing reaction compared with the initial irrigation water. The oxidizing of

drainage waters is caused by the removal of the acid products of the breakdown of the mineral and organic parts of the peaty soil stratum, which develops more intensively under moisture conditions.

The high percentage of washing-off of mineral salts and organic matter is characteristic of the first stages of influence of irrigation water on peaty soil. Subsequently, the washing-off process is stabilized and declines. This pattern is clearly visible in the experiment conducted in a 120X128X130 cm metal tank. The soil from the experimental sector was placed on a stratified basis and the density of the strata matched natural conditions. The bottom was covered by a 60-cm thick sandy stratum (in which clay types 75 mm in diameter were laid), covered by a 60-cm thick peat stratum. This structure was consistent with the genetic characteristics of the peaty-gley soils of the experimental sector.

The soil was watered with the waste water of the fine wool factory with a maximum norm of 1800 cubic meters per hectare. In the course of the experiment a filtrate was formed. Time samples were taken. The first was taken after 3 hours; the second after 6, and the third 24 hours after the beginning of the experiment. Table 2 shows the composition of irrigation and drainage waters (lysimetric). The table shows that the first and second samples contain more potassium, magnesium, organic matter, and sulfate ions. The third sample contains considerably less potassium, magnesium, sulfate-ions, and organic matter. Consequently, the leaching process of bivalent cation salts and organic substances develops unevenly and depends on the volume of water (irrigation norm) and effect time.

Considering the data thus obtained from the viewpoint of the effect of the cleaning, a well-expressed pattern is visible: the high absorption by peaty soils or organic matter, nitrogen compounds, bicarbonates, and dyes. With the passing of time the influence of the waste water and the soil increases the treatment effect. With heavy irrigation norms (1000 cubic meters per hectare or more) the effect of the treatment is high in a single irrigation. Thus, the absorption level is 76-88% for organic matter, and 80-90% for bicarbonates and nitrogen compounds. However, with such an irrigation load large quantities of mineral and calcium salts are leached out of the soil which is not advantageous from the land reclamation viewpoint. The systematic leaching of calcium soils could lead to a durable soil acidification of the soil which would adversely affect the growth and development of farm crops.

Under natural conditions the experimental drained plot consisted of peaty-gley soils. The thickness of the peat stratum varied from 30 to 70 cm. Peat strata are underlined by clay strata. Perennial grasses are grown on the plot — English bluegrass and timothy. The irrigation system included seasonal and nonseasonal irrigation. The seasonal irrigation with waste water (m=100-300 cubic meters per hectare) is accomplished with sprinkling from stationary pipe sprinklers of the DA-2 type while the flood irrigation method was used in nonseasonal irrigation. The usual irrigation norm was between 2500 and 3000 cubic meters per hectare per year. Earthenware pipes

and a network of open canals were used to drain the plot. The drainage lines were located each 30 and 21 meters with a 50-meter interval between ditches. The depth of the drainage and the canals averaged 1 meter. Systematic observations were conducted over the amount of the forming drainage waters and their quality.

Table 3 contains data on the composition of the waste water of fine woolen fabric factory used for irrigation and on the structure of drain waters before and after irrigation based on the norm of 1500 cubic meters per hectare. The flood irrigation took place in December 1973. The resulting data essentially confirm the patterns determined in the course of laboratory experiments. Waste water irrigation creates calcium sulfate leaching. Under natural conditions, however, this is an insignificant process. It is caused, on the one hand, by the fact that the leaching process has stabilized, since such irrigation has taken place over a period of several years and, on the other, the fact that under natural conditions the composition of soils is somewhat denser than in a laboratory. The data of the study show that with this irrigation system a high treatment effect was achieved. This is confirmed by the low bichromatic acidification of drain waters and their low content of general and ammonia nitrogen. Compared with the initial water the content of nitrogen compounds and organic matter in the drain waters was 8 to 25 times lower. Unlike waste water drain water contains no dyes and includes an insignificant amount of suspended matter. Consequently, the peaty-sandy stratum fully absorbs all suspended, dyeing, and diluted organic matter and nitrogen compounds.

Microbiological research data confirm the high results of the flushing with such an irrigation system. In all the variants, the microbiological activeness of the soils was higher as a result of waste water irrigation. In the covered draining system with a 30 meter interval between drains the overall amount of microorganisms and bacteria was 43% higher compared with the control variant. The number of ammonificating bacteria becomes particularly high, confirming the increased intensiveness of the breakdown of nitrogen-containing matter. The nitrifying activeness of the irrigated variants was somewhat lower than at the nonirrigated ones, explained by the adverse water-air soil system. All variants irrigated with waste water showed a more intensive development of cellulose breaking bacteria. The cellulose breaking activeness of the soil was 6-34.6% higher compared with the nonirrigated control variant. This proved the intensive breakdown of cellulose and of all nitrogen-free organic matter.

The irrigation system used for perennial grasses (3500-3000 cubic meters per hectare per year) could be considered optimum, for it insures the washing and decontamination of waste water and an 18.5% grass crop increase compared with the nonirrigated variant.

Table 1

Analysis of Lysimetric Water, mg/liter

Таблица I

Анализ лизиметрических вод, мг/л

Вариант опыта (1)		pH	Остаток (2)			Азот (6)		HCO_3	Cl	SO_4	Ca	Mg	K	Na	Окисл. бихр. (9)	P_2O_5
			взвеш. осадок (3)	сухой (4)	прокал. (5)	общ. (7)	аммиачн. (8)									
(10) Лизиметр 1	полив дистиллированной водой (13)	6,7	74	3760	2795	I3,7	6,4	55	40,8	I775	436	252	7,0	4I	467	нет
(11) Лизиметр 2		3,6	249	4395	3460	25,7	20,7	-	26,6	2629	450	323	I0,3	47,5	56I	"
(12) Лизиметр 3		3,85	3I3	4370	3425	28,2	I9,0	-	35,5	2709	480	330	I5	48	70I	"
(14) Лизиметр 4	полив сточной водой (17)	4,65	486	4735	3335	23,9	2I,6	30,5	26,6	2527	480	376	9,6	42,5	70I	"
(15) Лизиметр 5		3,65	I62	3540	2740	24,3	I7,0	-	35,5	22I0	446	246	I2	37	70I	
(16) Лизиметр 6		3,I5	302	4260	3260	5I	4I,0	-	35,5	2905	460	295	I0,3	49	70I	"
(18) Купавинская вода		6,95	380	635	420	-	32,0	290	80	I68	26	I45	6,5	7I	I308	"

Key:

1. Experiment
2. Residue
3. Suspended residue
4. Dry
5. Hardened
6. Nitrogen
7. Total
8. Ammonium
9. Bichromate acidification
10. Lysimeter 1
11. Lysimeter 2
12. Lysimeter 3
13. Distilled water irrigation
14. Lysimeter 4
15. Lysimeter 5
16. Lysimeter 6
17. Waste water irrigation
18. Kupava water

Table 2

Effect of the Treatment of Waste Water of the Fine-Woolen Cloth Factory on Peaty-Gley Soil and Degree of Leaching of Mineral Salts (mg/liter) with a 1800-Cubic Meters per Hectare Irrigation Norm

Т а б л и ц а 2

Эффект очистки сточных вод тонкосуконной фабрики торфяно-глеевой почвой и степень выщелачивания минеральных солей (мг/л) при норме полива 1800 м^3/га

Варианты опыта (1)	pH	Взвеш. осадок (2)	Остаток (3)		Азот (6)		HCO_3	Cl	SO_4	Ca	Mg	K	Na	P_2O_5	Окисляемость (9)	
			сухой (4)	прокален. (5)	общ. (7)	аммиачн. (8)									перм. (10)	бихр. (11)
(12) Сточная вода (I6/Y I973г.)	6,7	46I	645	285	37	-	I80	92,3	89	68	I9,2	9,5	88	следы	I6,32	768
(13) Первая порция 3 дрен (I6/Y)	4,7	622	4000	I335	3,9	2,2	I5,3	37,3	24I6	648	290	I6,5	42	-	30,4	I92
(14) Вторая порция 3 дрен (I6/Y)	4,9	252	4005	2905	3,2	I,I	9,2	33,7	27I4	632	325	I5,9	42	-	I2,8	I28
(15) Третья порция 3 дрен (I7/Y)	5,6	229	3985	II30	6,4	I,I	I5,3	35,5	24I0	6I4	288	I6,0	40	-	II,2	96

Key:

1. Experiment
2. Suspended sediment
3. Residue
4. Dry
5. Hardened
6. Nitrogen
7. Total
8. Ammonium
9. Oxidability
10. Permanent
11. Bichromatic
12. Waste water (16 May 1973)
13. First sample 3 drainages (16 May)
14. Second sample 3 drainages (16 May)
15. Third sample 3 drainages (17 May)

Table 3

Effectiveness of the Treatment of Waste Water of the Fine-Woolen Fabric Factory by Peaty-Gley Soils (mg/liter) with a Flood Irrigation Norm of 1500 cubic meters per hectare

Таблица 3

Эффективность очистки сточных вод тонкосуконной фабрики торфяно-глеевыми почвами (мг/л) при поливе напуском нормой I500 м^3/га

Место отбора (1)	pH	Взвеш. осадок (2)	Остаток (3)		Азот (6)		HCO_3	SO_4	Cl	Ca	Mg	K	Na	Окисл. бихр. (9)	P_2O_5	Железо (10)
			сухой (4)	прокален. (5)	общ. (7)	аммиач. (8)										
(11) Купавинская сточная вода	6,65	I00,5	735	260	57	46,8	I59	268	80	52	I9	9	90	896	(19) следы	I,5
(12) Дрена 7 до полива	7,65	I3,5	2I40	525	I,8	0,8	247	386	50	I76	46	5	57	I28	нет (20)	0,I
(13) Дрена 7 после полива: 2-й день	7,35	I6,0	I000	235	I,7	0,8	268	4I7	48	I86	44	4,5	66	I28	нет	0,2
(14) 3-й день	6,85	32,0	II65	2I0	2,2	I,I	2I7	579	36	2I6	44	4,5	72	96	нет	0,7
(15) 4-й день	6,90	20,5	II35	230	3,I	0,6	2I7	597	34	222	38	4,5	76	96	нет	0,8
(16) Дрена 6 после полива: 2-й день	6,I5	27,5	I255	I90	6,3	4,5	I0,7	66I	55	230	47	6	82	320	нет	I,2
(17) 3-й день	6,35	26,5	I335	235	6,5	4,5	I07	7I6	55	244	46	6	82	I28	нет	0,8
(18) 4-й день	6,75	26,0	I380	2I5	5,0	4,2	II3	754	55	248	48	7	94	I28	нет	0,3

Key:

1. Location
2. Suspended sediment
3. Residue
4. Dry
5. Hardened
6. Nitrogen
7. Total
8. Ammonium
9. Bichromate acidification
10. Iron
11. Kupava waste water
12. Drain 7 for irrigation
13. Drain 7 after irrigation: 2d day
14. 3d day
15. 4th day
16. Drain 6 after irrigation: 2d day
17. 3d day
18. 4th day
19. Traces
20. None

UDC 628.3+611.018.4+636.92

CYTOGENETIC CHARACTERISTICS OF MARROW CELLS OF RABBITS FED WITH PLANTS RAISED ON IRRIGATION FARM LAND

TSITOGENETICHESKAYA KHARAKTERISTIKA KLETOK KOSTNOGO MOZGA KROLIKOV V USLOVIYAKH KORMLENIYA IKH RASTENIYEVODCHESKOY PRODUKTSIYEY VYRASHCHENNOY NA ZPO in Russian pp 111-118

[Article by Candidate of Veterinary Sciences V. P. Sayapin and Junior Scientific Associate Yu. I. Tararin (VNIISSV)]

The sanitary evaluation of the forage output grown on irrigated farmland is required in the utilization of industrial waste waters for irrigation with a view to preventing its possible harmful influence on the animals. This is due to the fact that a variety of toxic chemical substances may penetrate into the crops from the waste water. Research related to the testing of plants grown on irrigated fields becomes particularly topical in terms of the study of its mutagenic effect. The need for such research is also dictated by the fact that cases of birth of defective children have been increased throughout the world. According to noted scientists this was caused by the presence of alien substances in food products [8]. Furthermore, so far the problem of minimally permissible doses of alien substances in nutrition products and their effect on the genetic foundations of the organism has not been developed.

The purpose of this project was to study the influence on the chromosome apparatus of the marrow cells of rabbits fed over long periods of time plants (hay, potatoes, wheat, oats) irrigated with the waste water of the Kupavna fine woolen fabric factory, to which residential waste water was added (20%).

Research Method

The experiment involved the use of 30 "Sovetskaya Shinshilla" breed rabbits, classified into six groups on the basis of the analog principle. Over a 2.5 year period the animals were fed rations balanced in terms of nutritional value in accordance with the norms developed by the All-Union Animal Husbandry Institute. The general ration fed to the first group of experimental rabbits was wheat; the second, oats; the fourth, potatoes; and the fifth, hay. The ration of the third group consisted entirely of feeds

(hay, wheat, oats, and potatoes) grown on the irrigation farmland of the VNIISSV. The control group of rabbits was fed goods grown on nonirrigated plots.

The irrigation norm for potatoes used as feed was 4070-6330 cubic meters per hectare, it was 1550-2020 for winter wheat, 1150-2200 for oats, and 5000-9200 cubic meters per hectare for perennial grasses for hay. The irrigation waste water composition was the following (in mg per liter): general nitrogen, 32; HCO_3^- - 182; Cl^-- 83-92; SO_4-172; Ca-44-50; Mg - 20-23; Na - 107; K - 7; P_2O_5 - traces; detergents - 3.7; chromium - 0.5; bichromatic oxidability - 528; and various organic dyes; the water pH was 6.7.

After a period of 2.5 years of feeding the animals plants grown on irrigated crop land the rabbits were killed through decapitation. The marrow cells were extracted from the upper part of the femoral bone by washing them with a 1.12% sodium citrate solution.

In order to accumulate metaphases, 3 hours prior to the slaughtering of the rabbits colchicine was injected (a 0.5% solution at the rate of 0.01 mg/gram of animal weight). The metaphasic preparation plates of the marrow were prepared according to the modified Ford method [7].

Five rabbits each were used for each experiment and control variant. Studies of 60 metaphasic plates of marrow cells were made per animal. Cells meeting the criteria formulated by Bochkov et al. [1] were selected for the study. Violations of chromosome numbers and structures were recorded for each metaphase plate. Gaps (achromatous blanks), fragments, and chromatid exchanges were recorded in the analysis of the nature of chromosome damages. The results were processed through the variation statistics method.

Study Results

Considering the already mentioned chemical composition of the waste water of the Kupavna factory, let us note the presence in it of a number of substances capable of creating pathological changes in the animals' organisms. Today we are familiar also with the mechanism of action of some of them on the biological functions of living cells. Thus, Cl^-, in 0.05-0.1% concentrations, changes the lipoid metabolism and leads to the accumulation of cardiolipins in the cytoplasm and the nucleoli of muscular cells.

It has been reported that in a 0.01-0.1% culture the concentration of Ca^{+2} ions stimulates the preparation process of inorganic phosphorus in cells taken from the hearts of chick embryos while its higher or lower content inhibits this reaction [9].

An excess of Fe^{2+} and SO_4^{-2} [11] leads to the increased activeness of oxidizing ferments and glucose phosphatase in rabbit liver cells.

There is very limited information on the genetic damages caused by substances present in waste water. Studying the influence of chromium on chromosome puffing in Drosophila melanogaster, Yu. L. Nikiforova et al. [4] drew the conclusion that it had a mutagenic effect expressed, according to the researchers, in the possibly total blocking of the ecdysone ferment responsible for chromosome puffing. Nitric acid and its derivants, needed in textile production, should be subjected to the most thorough studies from the metagenic viewpoint. Interacting with the amino group bases (A, D, V), they form diazonium salts which rapidly disintegrate with the separation of the nitrogen, which may result in a chromosome breakdown (deletion) [5]. Taking into consideration the relatively high content of the mentioned substances in waste water we should expect that plants grown on irrigated farmland would possess mutagenic characteristics and trigger changes in the hereditary structure of the organism.

In the case of our experiment of the study of marrow cell chromosomes the control animals revealed an insignificant number of cells with structural and polyploid disturbances, respectively (3.86 ± 1.87 and $2.66 \pm 1.60\%$). The structure aberrations in the control animals consisted only of isolated chromatid fragments. We noted three cells with pre-mutation damages-gaps (1%). In the control animals the overall percentage of disturbed cells equalled 4.35%. The results of our observations of structural chromosome disturbances (3.86%) coincide with the data provided by O. T. Movchan and others [6], who established 3.5% chromosome aberrations in chinchilla breed control rabbits. One of the indicators for the assessment of the mutagenic action could be the presence of achromatic gaps in the chromosomes of marrow cells which could disturb chromosome integrity [2]. In our experiment the number of recorded cells with premutation disturbances-genes (1 ± 0.09) in the experimental rabbit groups rose (compared with the control group) in the first, second, third, and fourth groups, while remaining almost identical in the fifth group (Table 1). These data prove the potential possibility for intensifying the mutation process in animals fed wheat, oats, and potatoes from irrigated fields.

The study of the polyploidal results (Table 1), i.e., the multiple increase of haploid number of chromosomes ($p=22$ in rabbits) indicated the presence of a large number of polyploid 3p and 4p polyploid cells in the fourth group animals (5.3 ± 2.31) and in the third group (7.99 ± 2.71), distinctly different from the control animals ($P<0.001$). This indicates the possible formation in the animals of the third and fourth groups of metabolites whose effect disturbs the process of chromosome dynamics and distribution in cellular division which, in turn, leads to the increased size of the cells and the breakdown of the tissue and, in the view of some scientists [3], proves a predisposition of such animals for lympoleucosis.

Table 1

Basic Types of Chromosome Disturbances in Rabbit Marrow Cells

Таблица I

Основные типы хромосомных нарушений в клетках костного мозга кроликов

Группы животных (1)	Число проанализированных (2): животных (3)	Число проанализированных (2): метафаз (4)	Предмутационные нарушения (5): гепы (6)	Предмутационные нарушения (5): % гепов (7)	Число перестроек (8), хроматидные (9): делеции (11)	Число перестроек (8), хроматидные (9): изохроматидные делеции (12)	Число перестроек (8), хроматидные (9): микрофрагменты (13)	Число перестроек (8), хроматидные (9): симметричные транслокации (14)	Число перестроек (8), хроматидные (9): асимметричные транслокации (15)	Число перестроек (8), хромосомные (10): делеции (11)	Число перестроек (8), хромосомные (10): симметричные транслокации (14)	Число перестроек (8), хромосомные (10): асимметричные транслокации (15)	Хромосомные перестройки от общего числа изученных метафаз (16): всего (17)	Хромосомные перестройки от общего числа изученных метафаз (16): %	Достоверность различий (P) (18)
(19) К	5	300	3	I,00±0,99	5	I	5	0	0	0	0	0	II	3,86±I,87	< 0,00I
I	5	300	8	2,66±I,00	24	2	8	I	I	3	I	0	40	I3,30±3,22	< 0,00I
2	5	300	7	2,33±I,5I	20	I	5	2	0	0	0	0	28	9,30±2,9I	< 0,00I
3	5	300	6	2,00±I,40	24	I	I	0	I	0	2	2	3I	I0,30±2,99	< 0,00I
4	5	300	5	I,67±I,27	35	4	9	I	0	4	0	I	54	I8,I0±3,78	< 0,00I
5	5	300	4	I,33±I,I3	II	0	3	0	0	2	0	0	I6	5,98± 2,37	> 0,I

Key:

1. Animal group
2. Studied number
3. Animals
4. Metaphases
5. Premutation disturbances
6. Gaps
7. Percentage of gaps
8. No of rearrangements
9. Chromatid
10. Chromosomal
11. Deletions
12. Isochromatid divisions
13. Microfragments
14. Symmetric translocations
15. Asymmetric translocations
16. Chromosome rearrangements in the overall number of studied metaphases
17. Total
18. Disparity reliability (P)
19. Control

Table 1 gives the results of the count of cultural chromosome aberrations. The frequency of cells with structural changes in the experimental groups (with the exception of group 5) reliably exceeds the level of chromosome disturbances in the control group ($P<0,001$). The highest number of cells with chromosome aberrations was recorded in the fourth group animals: $18.10 \pm 3.78\%$. The mutagenic effect of the feed ration was expressed in this group animals through the manifestation of isochromatid deletions, micro-fragments, and isolated symmetric and asymmetric translocations. This confirms the higher mutagenic effect of potatoes grown on irrigated crop land compared with other types of fodder crops. The number of marrow cells with chromosome aberrations in animals fed grain from irrigated crop land is lower than in the fourth group animals as follows: first group -- $13.30 \pm 3.22\%$; second group -- $9.30 \pm 2.31\%$. The marrow cells of animals fed hay from irrigated crop land showed an insignificant increase in the number of chromatid deletions ($5.98 \pm 2.37\%$), not reliably distinct from the control group ($P>0.1$).

Therefore, chromatid type aberrations essentially predominate in the feeding of rabbits produce raised on irrigated fields, regardless of species. The main type of aberration is that of isolated deletion fragments which arise as a result of the chromatid break. Since such disturbances are characteristic of spontaneous mutation, the assumption may be expressed that goods grown on irrigated crop land have a relatively light and, possibly, indirect mutagenic effect.

It is interesting to note that the number of chromosome damages caused by mixed feeds (third group $10.3 \pm 2.99\%$) is lower than in the separate use as feed of wheat (13.3 ± 3.225) and potatoes ($18.31 \pm 3.7\%$) grown on irrigated crop land. This may be related to a certain reciprocal abatement of the muta-genic activity of the individual ingredients as a result of a selective accumulation in different plant species. However, regardless of the possible effect of the abatement of the mutagenic action of potatoes and wheat, the percentage of disturbed marrow cells in animals fed the maximum selection of feeds grown on irrigated crop land remains sufficiently high (10.3 ± 2.99) compared with the control group ($P<0.002$).

The overall number of marrow cell disturbances developing in feeding rabbits produce from irrigated fields may be seen in Table 2 (absolute % of damaged cells). The study of the overall number of disturbances reveals the same pattern as that of chromosome aberrations. The highest mutagenic effect was noted in the use in animal feeds of potatoes grown on irrigated crop land (23.2%) and a maximal combination of feeds grown on irrigated crop land (18.3%).

The mutagenic effect detected in grain feed nutrition was somewhat lesser: wheat (16.0%) and oats (11.6%); there were practically no deviations from the control group (6.3%) in the introduction of hay grown on irrigated crop land (6.68%).

Table 2

Basic Types of Cytogenetic Disturbances in Rabbit Marrow Cells

Таблица 2

Основные виды цитогенетических нарушений в клетках костного мозга кролика

Группы животных (1)	Число проанализированных (2)		Мутационные изменения (5)								
	животных (3)	метафаз (4)	полиплоидные клетки (6)	% полиплоидных клеток (7)	достоверность различий (P) (8)	хромосомные перестройки (9)	% хромосомных перестроек (10)	достоверность различий (P) (8)	абсолютное число клеток с нарушениями (11)	% клеток с нарушениями (12)	достоверность различий (P) (8)
(13) К	5	300	2	0,66±0,08I		II	I3,86±I,87		I3	4,35±2,43	
I	5	300	8	2,66±I,6I	> 0,I	40	I3,30±3,22	< 0,00I	48	I6,00±3,87	< 0,00I
2	5	300	8	2,66±I,6I	> 0,I	28	9,30±2,9I	< 0,00I	35	II,60±3,53	< 0,00I
3	5	300	24	7,99±2,7I	< 0,00I	3I	I0,30±2,99	< 0,00I	55	I8,30±3,76	< 0,00I
4	5	300	I6	5,30±2,3I	< 0,00I	54	I8,I0±3,78	< 0,00I	70	23,20±4,35	< 0,00I
5	5	300	2	0,66±0,08I	> 0,I	I6	6,00±2,37	> 0,I	I8	5,98±2,49	> 0,I

Key:

1. Animal group
2. No of studied
3. Animals
4. Metaphases
5. Mutation changes
6. Polyploid cells
7. % of polyploid cells
8. Reliability of differences (P)
9. Chromosome rearrangements
10. Percentage of chromosome rearrangements
11. Absolute number of disturbed cells
12. Percentage of disturbed cells
13. Control

In the majority of cases marrow cells with chromosome aberrations perish. This may lead to a destruction of the marrow tissue which creates pathological deviations in the physiological condition of the animal and its death. In a study of rats Marinone [10] observed marow tissue degeneration in 30 to 40% of chromosome aberrations of marrow cells.

In our experiments the highest percentage of chromosome aberrations was noted in fourth group animals (18.2%). However, even in that group no obvious pathological deviations in the physiological condition were noted. This indicates that, thanks to its ability to proliferate, the rabbit marrow tissue could compensate for 18% of the eliminated cells with chromosome aberrations developing as a result of feeding the animals the farm produce grown on irrigated crop land we studied. Nevertheless, the existence of cells with mutation changes in the rabbits' marrow leads us to the assumption that the farm crops grown on irrigated crop land we studied (wheat, oats, potatoes) could have a mutagenic effect on other body tissues as well. The accumulation of mutated cells in the liver, muscular and nervous tissues could be expected [2], since the elimination of cells with a broken chromosome apparatus in such tissues is greatly slowed down because of low mitotic activeness. Such accumulation of mutations may lead to the fact that at a certain stage in life the tissue becomes functionally deficient resulting in the death of the animal. This requires great caution in the assessment of the mutagenic influence of goods grown on irrigated crop land. The solution of this problem would be achieved only through the comprehensive study of the entire animal organism.

The conducted studies indicated the following:

The extensive use in rabbit food rations (over 2.5 years) of some types of crops grown on irrigated crop land (potatoes, wheat, oats and their mixes) leads to the appearance of chromosome breakage in the animals' marrow cells;

The extent of this breakage depends on the forage structure: the greatest number of changes in the chromosomal structure of rabbit marrow cells was noted when potatoes were included in the ration while the number was lesser in the use of wheat, oats and mixed fodder grown on irrigated crop land.

The extensive use of hay grown on irrigated crop land in the feed ration had no mutagenic effect on the chromosomal apparatus of rabbit marrow cells.

BIBLIOGRAPHY

I. Б о ч к о в Н.П., Д е м и н Ю.С., Л у ч н и к Н.В. Классификация и методы учета хромосомных аберраций в соматических клетках. - "Генетика", 1972, т.8, № 5.

2. Д у б и н и н Н.П. Об основных факторах естественного мутационного процесса. - "Бот.журнал", 1958, т.43, № 8.

3. Ж и в а л е в И.П., Г о л ь д м а н И.Л. Полиплоидные клетки гемопоэтической ткани крупного рогатого скота в норме и при лейкозе. - "Цитология и генетика", 1973, т.7, № 3.

4. Н и к и ф о р о в а Ю.Л., С а х а р о в а М.М., Б е л н а з а р ь я н ц И.А., Р а п п о п о р т И.А. Специфическое воздействие хрома на характер пуффообразования у Drosophila melanogaster - Доклады АН СССР, серия Биология, 1970, т.194, № 2.

5. С о й ф е р В.Н. Молекулярные механизмы мутагенеза. "Наука", 1969.

6. Chinoy N.J. Cytochemical observation on the effect of carbon tetrachloride on lipids in cultured muscle. J. Animal Morphol and Physiol. 13, 1-2, 63-66. 1966.

7. Ford E.N., Woollam D.H. A colchicine. hypotonic sitrate, air drying sequence for foetall mammalian chromosomes. Stain technologi 38, 5, 271-274, 1963.

8. Heyne D. Arch. belges med. sociale, 21, 3, 186-190, 1963. (Р.Ж. Биология 3, 4265 (04), 1964).

9. Klein R.L. Ca^{+2} requirement for Na^{+} Stimulated Mg^{+2} Pose in nuclei isolated from embryone heart. Exptl. cell. Res. 49, 1, 69-78, 1968.

10. Marinone J., Marine J. Robustelli della Cuna J. "Studi citologici citogenetici sulle lesioni midollari sperimentali da damnomicina," Haematologica, 52, 7, 503-530, 1967.

11. Witsleben C.L., Chofey N.J. Acute ferrouns salfatepoisonins. Arch. Pathol., 82, 5, 454-461, 1967.

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INFLUENCE OF FEEDING PRODUCE GROWN ON IRRIGATED CROP LAND ON THE IMMUNOLOGICAL REACTIVITY IN RABBITS

VLIYANIYE SKARMLIVANIYA PRODUKTSII S ZPO NA IMMUNOLOGICHESKUYU REAKTIVNOST' ORGANIZMA KROLIKOV in Russian pp 119-122

[Article by Candidate of Veterinary Sciences V. P. Sayapin and Candidate of Biological Sciences N. I. Matulyavichene (VNIISSV)]

Natural-biological methods for the purification of waste water on irrigated fields are assuming great importance in the set of water preservation measures. The development of irrigated farm land enable us to resolve many national economic problems related to the purification and final purification of waste water, and the protection of water sources from pollution. It offers extensive opportunities for high and stable yields as a result of soil moisture and application of additional nutritive substances contained in waste water. It may be assumed that feed crops grown on irrigated fields will assume in the near future a considerable role in the overall fodder balance of the country's animal husbandry.

In this connection the need arises for engaging in toxical hygienic studies of crops grown on irrigated farm land, since harmful and toxic substances may penetrate into farm crops from the waste water. Important among such studies is the study of nonspecific and specific natural immunity factors.

We know that environmental factors have a constant influence on the animal's organism throughout its life. Thus, according to public data, the care conditions, level of feeding, and a number of factors have a definite influence on the restructuring of the organism. In a number of disturbances occurring in the animal's organism, above all, those related to metabolism, the immunological reactiveness of the organism is considerably reduced and suppressed.

Extensive studies conducted by the VNIISSV of the waters released by the Kupavna fine woolen fabrics factory prove that in the course of the production of textiles detergents, chromium and a variety of organic dyes may find their way in waste water. It has been established that detergents and chromium applied on irrigated fields with waste water may accumulated in the

soil and, subsequently, in farm crops. The use of such crops in animal feed rations could create various disturbances in the functional state of the organism.

Immunological studies play a particular role in assessing the intimate aspect of the physiological condition of the organism and in the early diagnosis of the toxicological effect of substances. Taking this into consideration, we undertook the study of the influence of some varieties of feed crops grown on irrigated crop land on the immunobiological reactiveness in experimental rabbits.

Research Method

The studies were conducted in the course of an uninterrupted experiment (6 months) using 30 chinchilla rabbits, classified on the basis of the analog principle into five groups (six per group). Over a 1-year period the animals were fed rations balanced in terms of nutritive value based on norms developed by the All-Union Animal Husbandry Institute. The first group of rabbits was fed wheat (30-35%) with digestible protein; the third was fed oats (35-40%); the fifth was fed potatoes (10-12%); and the sixth was fed hay (40-45%). The ration of the second (control) rabbit group consisted of feeds grown on nonirrigated plots.

The irrigation norm was 5000-6500 cubic meters per hectare for perennial hay grasses, 1550 for winter wheat, 1150 for oats, and 6330 cubic meters per hectare for potatoes.

The complementary, lysozymic, and bactericidal activities of blood serum were used as indicators. The agglutination reaction was used in assessing specific immunological reactiveness.

After the initial indicators were defined, the rabbits of all five groups were twice immunized in doses of 0.5-1 milligram of formalin-alum vaccine against calf paratyphoid, containing 1 billion microbes per milligram, within a 7-day interval. Against the background of this immunization, in the course of the development of the experiment, indicators of the natural resistance shown by the rabbits were studied according to the following methods: the titer of the complement was determined with the complement titration method based on 100% hemolysis; lysozyme titration was determined according to the method developed by Z. V. Yermol'yeva; bactericidal activity was determined according to the photonephelometric method (according to O. V. Smirnova and T. A. Kuz'mina); the classical agglutination method was used in assessing specific reactiveness.

The results of the studies were processed in accordance with the variation statistics methods. A disparity of $P<0.05$ was considered reliable.

Results

The study of the data indicated that at the moment of immunization (i.e., 1 year after the rabbits were fed the special rations) the lowest complement titer was noted in the fifth group rabbits (7.90 ± 0.12), compared with 14.0 ± 0.29 in the control group ($P<0.001$). The lowest disparity compared with the control group was found among the sixth group rabbits whose ration included hay grown on the irrigated lots. At the end of the experiment (6 months later) substantial changes were noted in groups 1 and 3, and it was only in group 6 that the complement titer was on the control group level.

A study of data characterizing lysozymic activeness leads us to note that at the beginning of our experiment (initial background) the lysozyme titer in group 5 was 50% lower (90.0 ± 4.4) compared with the control group (180 ± 8.9) ($P<0.001$). One month later the lysozymic activeness of the blood serum in the experimental rabbits dropped sharply by approximately 4-5 times. After 2, 3 and 6 months the lysozyme titer began to rebuild itself slowly. By the sixth month, however, it had still not reached its initial figure. The results of the studies of the individual experimental rabbit groups indicated the reliable lysozymic titer changes were noted in all groups other than group 6 in which it was (116.66 ± 14.06) compared with (150.00 ± 10.0) in the control group ($P>0.1$).

The bactericidal activeness of the blood serum in the different groups showed a lowering trend in the first 2 months of observation. Drastically distinct was the bactericidal activeness indicator of the fifth group (17.86 ± 2.25) compared with the control group (55.56 ± 5.0) ($P<0.002$). The closest to the control group was the bactericidal indicator of the blood serum in the sixth group. Bactericidal activeness indicators of the first and third groups were in an intermediary position. Minimal levels of bactericidal activeness were noted for the period of the first 2 months in all studied groups. Subsequently a tendency toward the restoration of activeness was noted and it reached its starting data in almost all the groups after 6 months.

Assessing the physiological condition of the animal's organism its ability to produce specific antibodies in response to an irritant with an antigenic capacity is assumed an important role. Following the introduction of an antigen in the animal a morphological and functional differentiation develops in the cells of the lymphoid system. They begin to produce particular proteinic substances — antibodies — as a result of which the organism becomes unreceptive to infectious diseases. Under the influence of adverse external factors (poor care and nutrition), the development of the specific resistance may be considerably suppressed as a result of the inhibition of processes of antibody biosynthesis.

Under the conditions of feeding the animals plants grown on irrigated crop land, noting changes in the nonspecific natural immunity factors, it was interesting to trace the development of immunity in the studied animals after a double immunization with formalin-alum vaccine against calf

paratyphoid. The preliminary studies preceding the immunization indicated that control and experimental animals of all groups developed a negative agglutination reaction. Following the first immunization, 7 days later, specific agglutinins were recorded in the blood serum of the control and experimental animals. However, their content in the blood serum varied among the different animal groups within a rather broad range. Thus, in the first and third rabbit groups agglutinin titers were practically identical to those of the control group. In the fifth group the agglutinin titer was (36.66 ± 9.54) compared with (120.00 ± 17.88) in the control group ($P<0.01$). In the sixth animal group the specific agglutinin titer was not substantially different from that of the control rabbit. The second immunization contributed to the even more intensive production of agglutinins. The maximum agglutinin titer in the experimental and control animals was recorded on the 21st day. However, the level of agglutinins within that time in all experimental animals (with the exception of group 6) was considerably lower compared with the control group. A similar situation was noted in the subsequent research periods. At the end of the experiment (after 6 months) a low agglutinin titer was noted in both experimental and control animal groups.

Such data lead to the assumption that feeding the animals some types of feed produce grown on irrigated crop land (potatoes, oats, wheat) has a certain influence on the immunological reorganization of the organism; clearly, this is related to the suppression of the functional condition of the organs responsible for the biosynthesis of agglutinins. Yet a feed such as hay grown on irrigated crop land has no adverse effect on immunological reactiveness.